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Engineering and Mining Journal

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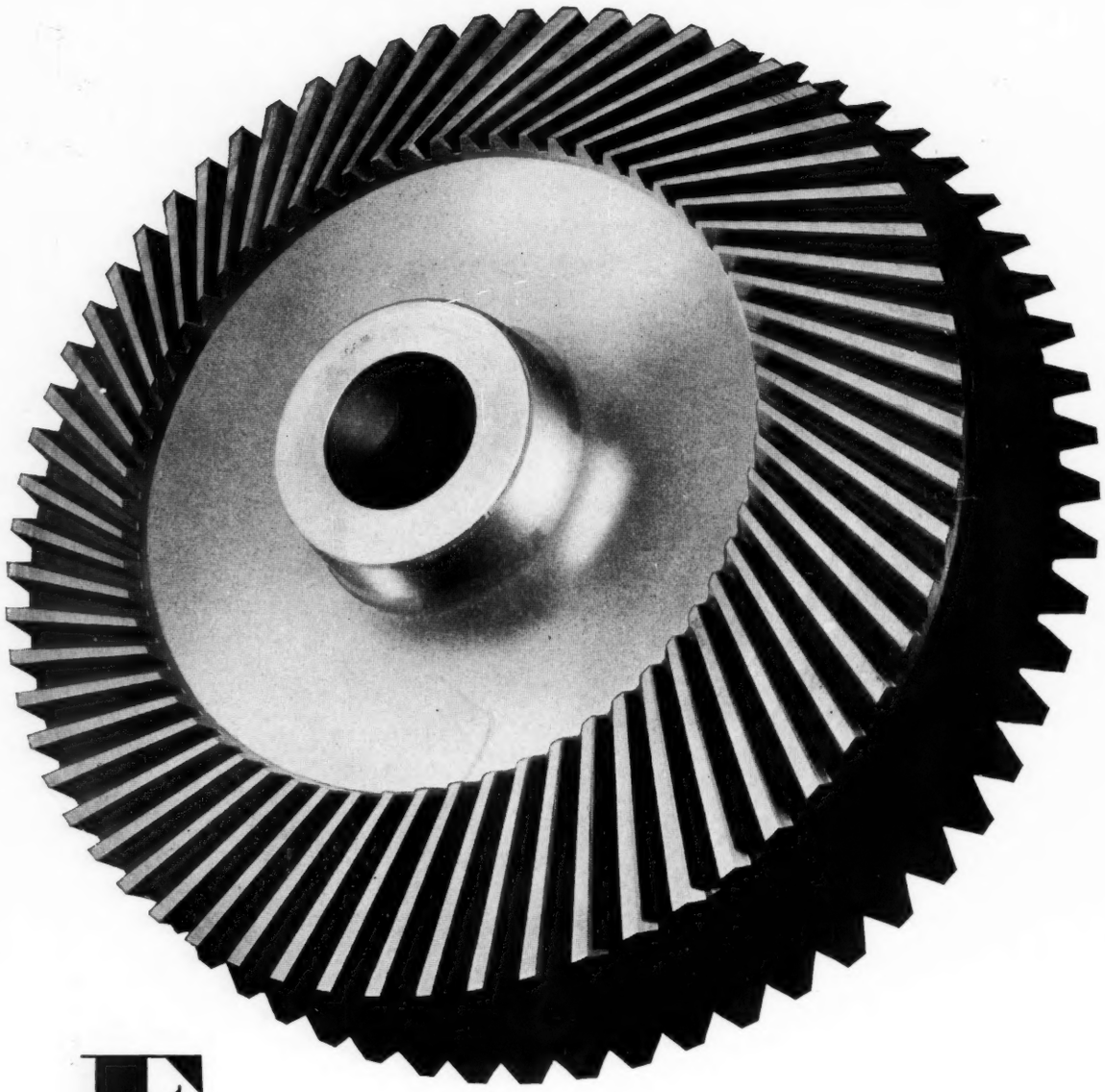
Robert J. McRae finances his way through University of Idaho by gold placer mining during vacations (see news section)

July 27, 1931



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Contents for July 27, 1931

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VOLUME 132 . . . NUMBER 2

Editorials 49

Men and Money Make Mines, Even Gold Mines . . . Technology, Not Finance or Politics . . . Prospecting-Pan Shortage Is Good News . . . Order Out of Chaos Through Standardization . . . Accident Avoidance and the Language Problem

India's Only Copper Producer ..... *R. B. Woakes* 51

Flotation of Hematite ..... *Adams, Kobey, and Sayers* 54

Preventing Accidents ..... *Pictorial Feature* 56

Tennessee Phosphate Deposits ..... *R. W. Smith* 58

Mining and Processing Cement Material ..... *J. B. Nealey* 63

Bin-Wall Pressure Chart ..... *S. C. Mifflen* 65

Mining Asphalt in Cuba ..... *A. E. Northey* 66

Copper Production Costs ..... *S. D. Strauss* 68

Flotation Reagents ..... *A. M. Gaudin* 70

Crushed-Stone Plant ..... *G. J. Young* 72

Book Reviews 75
Comment, Criticism, Personals 77
Industrial Progress 79
News of the Industry 82
Market and Financial News 89
Searchlight Section 26
Professional Directory 28
Advertising Index 30

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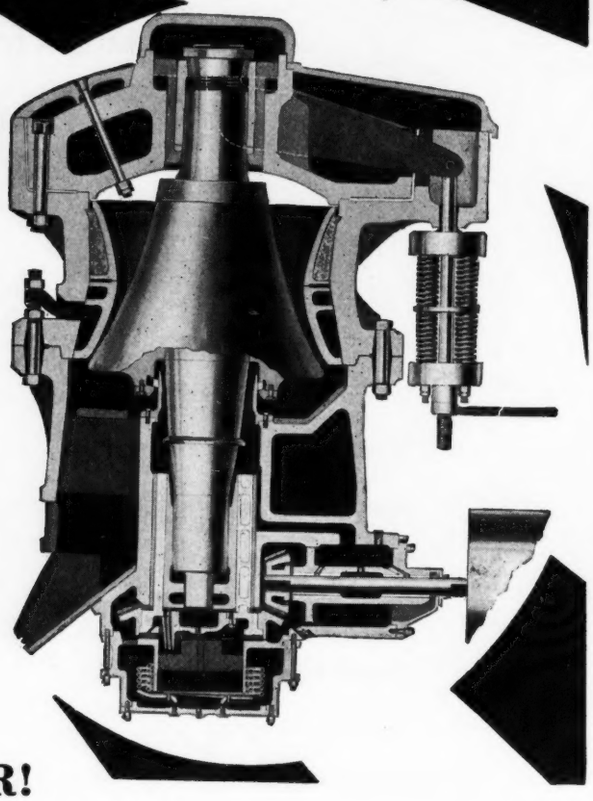

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Engineering and Mining Journal

July 27, 1931 A. W. ALLEN, *Editor* Vol. 132—No. 2

Men and Money Make Mines, Even Gold Mines

GOLD MINING has been the subject of more than its usual share of attention during the present world-wide depression. Optimism is a more common trait in the human animal than is pessimism. Consequently, an industry that is immune to depression—that, in fact, thrives on lower commodity prices—becomes a favorite subject for mental (and financial) speculation. An added cause for discussion of gold mining is the possibility, suggested by many economists, that insufficient gold is the cause of low commodity prices. Whether sharing this opinion or no, everyone unites in agreeing that a gold boom at this time would be a definite benefit to industry as a whole.

The flood of publicity on gold mining has little effect in stimulating production. If high-grade surface deposits of the precious metal were still common, to draw the attention of the general public to gold mining as a possibly lucrative investment would be of definite value. Unfortunately, high-grade surface deposits are not common. As year follows year, and prospecting efforts fail to uncover evidences of a new Goldfield or a new Cripple Creek, the possibilities become more and more limited. The future of gold production lies largely in the exploitation of large low-grade deposits, deposits that will require considerable capital to explore and equip. Such work is being undertaken by several mining companies. The latest example is the optioning of a mine, in Victoria, Australia, by Broken Hill Proprietary. Ventures, Limited, is proving a lode of apparently great promise at the Beatty property, in Quebec. Treadwell Yukon and Homestake, both companies with a wealth of experience in handling low-grade gold ores, are testing a similar deposit at Bodie, California. These activities are in the right direction, but no extraordinary gifts of prophetic instinct are needed to predict that much more could be done if men were willing and sufficient money were available.

The men and the money are not easily available. To look to the general public for the financing of the development of a low-grade gold deposit is to be more hopeful than wise. The nature of such a project is not attractive to the small investor. Low-grade gold deposits, like low-grade copper, can, strictly speaking, be financed only by organizations with wide experience in the mining industry —the Hayden-Stone, Guggenheim, Bradley, or similar groups.

But, even were money available, there are indications that the men to direct its expenditure are not too plentiful. An instance of the long failure to apply principles which have been known for many years is the recent successful exploitation of low-grade gold-copper gossans at the Mountain Copper Company's property in Shasta County, California. Every important feature of the simple leaching practice now employed was practiced more than thirty years ago.

Wider recognition is needed of the inherent simplicity of certain metallurgical principles. Too many metallurgists appear afraid to apply to gold what they have applied to copper. Eventually, as more men become familiar with the treatment of low-grade gold ore, this situation will be remedied. May the change come soon.

Technology, not Finance or Politics

REQUESTS come so often to the editors of *Engineering and Mining Journal* for information on stock-market promotions and share values that we are obliged to remind our readers that this is not a financial magazine. Our major duty and purpose is to outline and present technical opportunities, to disseminate news and engineering information for the manager of mineral properties and for the operator of mine or mill or smelter. A publication such as this must stand or fall according to the success achieved in the field of practical engineering—technical, professional, managerial, humanitarian. Its first task is to cover the ground in this direction as thoroughly as possible, and experience shows that much remains to be done.

Mining operations depend so closely on general economic equilibrium that non-technical subjects occasionally call for treatment and discussion. The scope for such discussion in a technical magazine, however, is strictly limited. Economic proposals that are provocative of prolonged controversy cannot occupy a major position in any issue. Unthinking and inexpert approval of several proposals in succession may provoke economic indigestion. One group may seek agreement and price enhancement for its product by international conference; another may be willing to risk international amity and invite retaliatory measures by urging the erection of exclusionary customs barriers. Both proposals may be worthy of support, each may be individually sound and desirable, but no one agency can promote both, achieve success, and escape adverse criticism. *Engineering and Mining Journal*, moreover, is not a lobbying agency, with facilities at the Capitol to further legislation. Another medium exists for that purpose; although, we regret to be compelled to observe,

it has expanded its activities in order to encroach on the field of the technical publication.

The circulation of *Engineering and Mining Journal* among Solons is negligible. If an indefinite amount of space were to be reserved for propaganda in favor of legislation in the interests of a section of our readers, the appeals would merely circulate back to those readers, without attracting the attention of elements capable of influencing the result in Congress. In the interests of its clientele, who are entitled to the latest and best in technical journalism, *Engineering and Mining Journal* is obliged to forego many temptations to discuss political and economic matters of interest and concern, remembering that it is primarily a technical magazine.

Prospecting-Pan Shortage Is Good News

ONE of the few items of equipment in the mining industry that remains in its original form, without improvement, is the prospecting pan. The inventive genius of the twentieth century has developed nothing that is more useful to the prospector, for the determination of "values," and for a rough assay estimation of free gold by the miner. The pan, about one foot in diameter, made of sheet iron, has remained unaffected by the modern urge for bigness and the trend toward the use of "quality" metals. The favorite substitute—an ordinary frying pan—finds as much favor today as it did when the "'forty-niners" went to California. The "colors" would not show so well in an aluminum pan, or in a stainless-steel one, as they do in one made of plain black iron or steel.

Activity in gold mining is reported from many districts, including Western Montana. The placer country north of Butte and Anaconda and west of Helena is attracting so much attention that the leading hardware store in Butte recently sold out its stock of miners' pans, and had to send to Minneapolis for a special consignment made to order. That they were made to order might suggest that Montana prospectors have devised a few frills in the way of improvements, but that is not likely. The prospecting pan is probably still of the same size, weight, dimensions, and material as of yore, requiring a knack to operate that every seasoned prospector possesses.

Order Out of Chaos Through Standardization

AT A TIME when the industrial system is the subject of criticism accusing it of lack of foresight and an absence of collective planning, evidence to the contrary is especially interesting. Such evidence is presented in the recently issued 1931 Year Book of the American Standards Association. For instance, after explaining that standardization is dynamic, not static—that it means not to stand still, but to move forward together—attention is directed to its practical value, particularly as demonstrated under the unfavorable economic conditions of 1930. Reference is made to a large company that guaranteed fifty weeks' work to employees in its incandescent-lamp department, where a standardized product is made. With standardization assuring a future market for the lamps, the company felt justified in manufacturing and stocking them in large quantities, well in advance of sales orders. During such a period the manufacturer can probably purchase, at reduced prices, the necessary raw materials, including those for the metal part of the lamp, thereby increasing the opportunity for profit.

Stabilization of production and employment, the Association points out, results from broadly accepted standardization, as well as lower costs to the consumer and a fair margin of profit to the manufacturer. An estimate, for example, has been made that the cost of the present type of light-weight automobile would be about $10,000 in the absence of standardized manufacture and the application of mass production methods that standardization makes possible. Any contention that standardization "freezes" practice, thwarting normal progress, is unfounded. Styling and beautification, as well as the development of improvements in basic designs, are promoted rather than retarded or sacrificed, the consumer receiving a product that is more efficient, economical, and pleasing to the eye than would be obtained otherwise.

Accident Avoidance and the Language Problem

THE National Safety Council, with headquarters at Chicago, Illinois, carries on a vigorous campaign of education by meetings, discussions, and safety-first literature of various kinds. Effective posters are designed and distributed to illustrate the opportunities for accident avoidance, and the advantages, to employee as well as to employer, of care and caution. The large proportion of mine and mill workers who read and speak English makes concentration of effort in poster design and wording an easy matter, with prospect of maximum result.

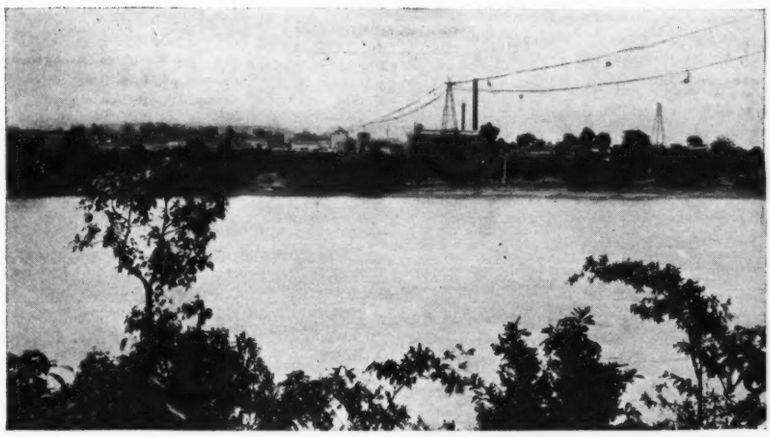
But what of those to whom English is an alien tongue, and they are legion? Next to English, the Spanish language is perhaps the most widely used in the mines, mills, and metallurgical plants of the world; but no central agency exists to collect and to disseminate literature and posters in Spanish. This deficiency has suggested to officials of the Moctezuma Copper Company, operating in Mexico as a subsidiary of the Phelps Dodge Corporation, that its Spanish-speaking employees could be educated to avoid accident most efficiently and most effectively by the use of photographs, taken in the company's mines and plants, contrasting safe practices with unsafe ones.

These pictures tell the whole story. They convey the lesson and infer the moral, without words. Through the courtesy and cooperation of Mr. P. G. Beckett, general manager of the Phelps Dodge Corporation, we are privileged to reproduce elsewhere in this issue typical photographs of this character now being used at the company's properties in northern Sonora. The practice described, and a study of the illustrations themselves, should suggest to mining companies in all parts of the world a method of diminishing hazard and preventing suffering and loss by accident, at comparatively small cost; a method, moreover, that will prove applicable and effective whatever the language is spoken.

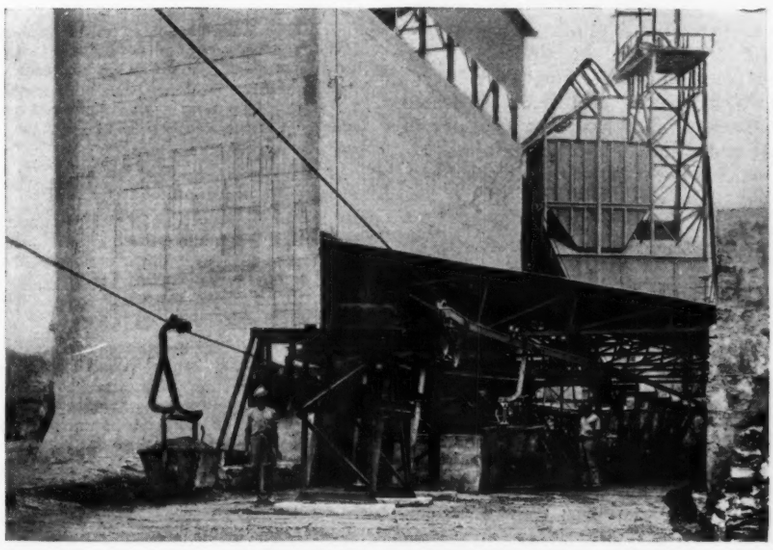
India's Only Copper Producer —the Indian Copper Corporation

Russell B. Woakes

General view of works, showing ore bins, concentrating mill, smelter, and pulverized-coal plant



General view of works site from west bank of river



Wire ropeway loading station

THE Indian Copper Corporation operates in the Singhbhum district, Bihar and Orissa, India, the property being 130 miles west of Calcutta on the main line of the Bengal Nagpur Railway, on either bank of the Subarnarekha River. Mining is now confined to the Mosaboni Mine, where, when productive operations began in January, 1929, developed ore reserves amounted to 755,630 tons (of 2,000 lb.) of an average grade of 3.78 per cent copper. The copper lodes occur in chlorite and granite schists dipping generally from 30 to 50 deg. to the northeast and striking fairly regularly in a general northwesterly and southeasterly direction. Essentially, the ore consists of chalcopyrite with small quantities of pyrrhotite. An average assay of mill feed shows 3.14 per cent of copper and 11 per cent iron. The lodes vary in both dip and thickness in different sections of the mine, which has a length along the strike of 3,000 ft. and a present depth of 500 ft. on the dip of the lode.

No definite system of mining is yet standard but bottom, flat back, and rill stoping, all with filling, are generally employed. Drilling is accomplished with jackhammers, telescopic stopehammers, and hammer drifters. All drills are manned with native labor, but the supervision of European shift bosses is essential. The main problem is the attainment of greater efficiency in the operation of machines by the labor that is available.

Hand tramming of ore from stopes to shaft ore bins is employed, but mechanical haulage by storage-battery locomotives has been tried on one level and can now definitely be reported as more efficient and satisfactory than hand tramming. Side-tipping U-shaped mine cars, of 16 cu.ft. capacity, fitted with roller bearings and running on an 18-in. track with 18-lb. rails, are employed. These will be replaced in the bottom of the mine as new levels are developed, by heavier equipment throughout, adapted for mechanical haulage.

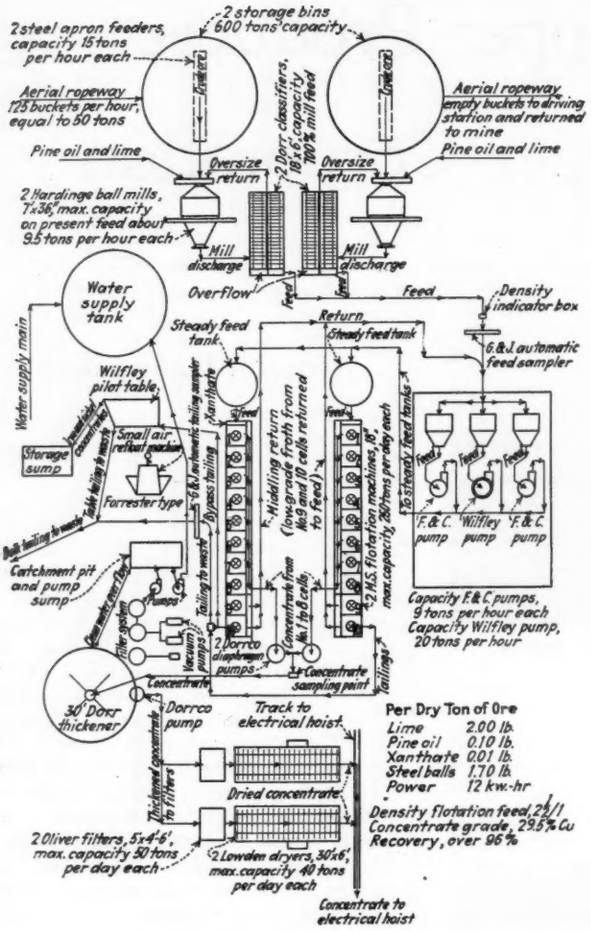

2 storage bins 600 tons capacity
2 steel apron feeders, capacity 15 tons per hour each
Aerial ropeway 125 buckets per hour, equal to 50 tons
Aerial ropeway empty buckets to driving station and returned to mine
Pine oil and lime
Oversize return
2 Dorr classifiers, 18'x6', capacity 700% mill feed
2 Hardinge ball mills, 7'x36" max. capacity on present feed about 9.5 tons per hour each
Mill discharge
Water supply tank
Overflow
Feed
Density indicator box
Return
Steady feed tank
6 & J automatic feed sampler
Water supply main
Wilfley pilot table
Storage sump
Small air reliant machine
Forrester type
Bulk tailing to waste
Middling return (low-grade froth from No. 9 and 10 cells returned to feed)
6 & J mechanic tailing sampler
Xanthate
Bypass tailing
2 H.S. flotation machines, 16" max. capacity 280 tons per day each
16 steady feed tanks
F. & C. pump
Wilfley pump
Capacity F. & C. pumps, 9 tons per hour each
Capacity Wilfley pump, 20 tons per hour
Catchment pit and pump sump
Tailing to waste
2 Dorrco diaphragm pumps
Concentrate from No. 1 to 8 cells
Vacuum pumps
Concentrate sampling point
Tailings
30' Dorr thickener
Concentrate
Dorrco pump
Track to electrical hoist
Per Dry Ton of Ore
Lime 2.00 lb.
Pine oil 0.10 lb.
Xanthate 0.01 lb.
Steel balls 1.70 lb.
Power 12 kw.-hr
Thickened concentrate to filters
Dried concentrate
Density flotation feed, 22/1
Concentrate grade, 29.5% Cu
Recovery, over 96%
2 Oliver filters, 5'x4'6', max. capacity 50 tons per day each
2 Lowden dryers, 30'x6', max. capacity 40 tons per day each
Concentrate to electrical hoist

Fig. 1—Flowsheet of concentrator

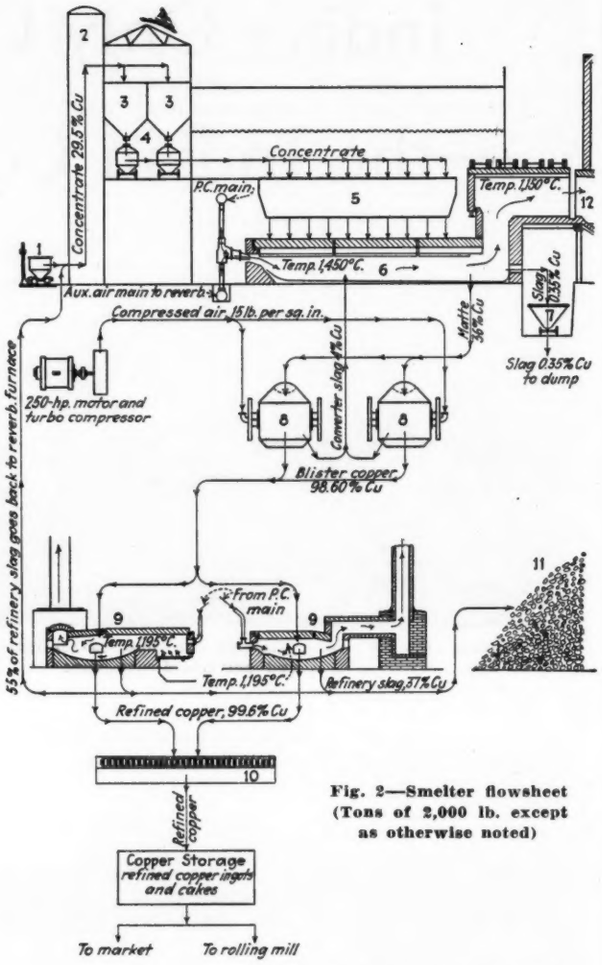


Fig. 2—Smelter flowsheet (Tons of 2,000 lb. except as otherwise noted)

The main lesson learned from our short experience is that the adoption of labor-saving devices is always justified, wherever their installation is feasible. At the same time, conscientious white supervision on a generous scale is essential if efficient results are desired. An increased supervisory staff has immediately given beneficial results in the form of reduced working costs and improvement in the grade of ore mined.

The contract system for ground broken has been given an extended trial and abandoned in favor of a basic rate for the actual footage of holes drilled. At present the latter system is working well, is popular with the labor, and gives better results than can be obtained from contractors. An average daily footage of 42 ft. per machine shift is now attained, but this can probably be improved materially.

All hoisting is done through the main shaft, which is centrally located to the known orebodies, and sunk at a fixed incline of 38 deg. to the horizontal. The shaft is equipped with a masonry arched collar, double 3-ft. 3-in. skip roads, 3-ton self-dumping skips, a 6-in. compressed air main, and ladder road. Level stations have been cut at the 200-, 350-, and 500-ft. levels, and each station is equipped with electric light and hanging-wall ore bins of approximately 250 tons' capacity each. No timber has been used in the construction of equipment of the shaft, and hoisting is therefore uninterrupted by delays due to repairs and maintenance. Pumping gives little or no trouble; water is elevated from the 500-ft. level by a 50-hp. electrically driven centrifugal pump of a capacity of 187 Imperial gal. per minute.

Surface equipment comprises:

Two two-stage electrically operated compressors, each having a capacity of 1,000 cu.ft. of free air per minute.

One double-drum 6x3-ft. electric hoist.

One Blake crusher 40x16 in.

One 4-ft. Symons cone crusher.

The two crushers are equipped with picking belt and the necessary conveyor belts to elevate all ore from the primary crushing plant to reinforced-concrete ore bins of 1,200 tons' capacity, which feed the wire-rope tramway.

Two Ingersoll-Rand No. 50 drill sharpeners, with oil-fired furnaces, deal with the sharpening of drill steel, and a standby steam-operated compressor is available in the event of a breakdown on the overhead electric power line, which comes from a power station 5½ miles away.

1. Concentrate car on weigh scale ready to go to bedding bins through electric hoist. Capacity of car, 1½ tons; of scale, 5 tons.

2. Electric hoist, capacity 3 long tons.

3. Concentrate bedding bins, capacity 400 tons.

4. Concentrate cars to feed bins over reverberatory furnace.

5. Two feed bins for reverberatory.

6. Reverberatory furnace. Total hearth area, 400 sq.ft. Three powdered-coal burners. Maximum capacity, 2,000 tons concentrate per month. Powdered-coal consumption at maximum rating, 700 long tons per month of which 350 long tons recovered as waste heat, equivalent to 270,000 kw.-hr. per month.

7. Slag pot, capacity 60 cu.ft. All slag to waste dump.

8. Two converters, 8 ft. diameter. Operating capacity of each, 415 tons blister copper per month, equal to 396 tons refined copper. Air from 3,000-cu.ft. turbo compressor, driven by 250-hp. motor.

9. Two refinery furnaces, one grate-fired and the other powdered-coal-fired. Operating capacity, 18 long tons refined copper per day. Fuel consumption, 3 long tons powdered coal, or 6 long tons lump coal, a day.

10. Three water boshes containing 60 ingot molds.

11. Refinery slag, 45 per cent stocked for future treatment.

12. Two waste-heat boilers.

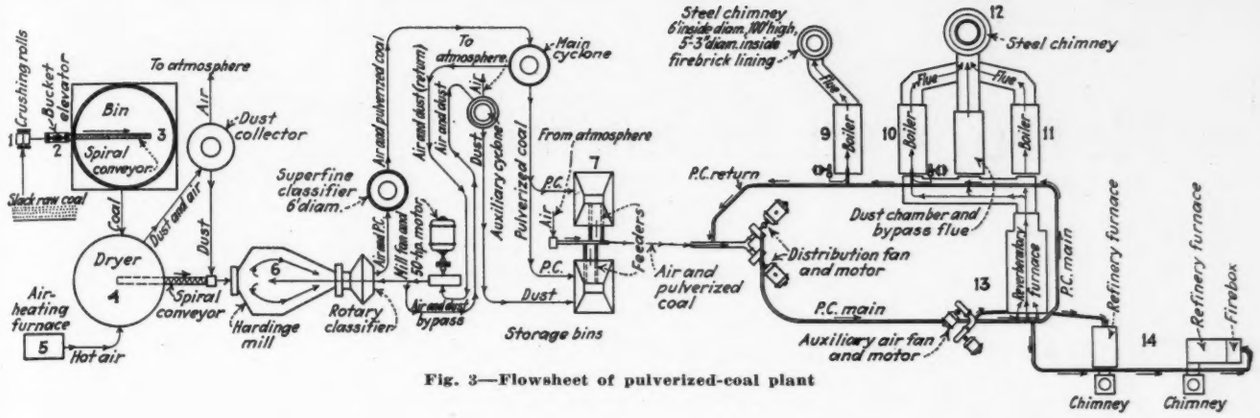


Fig. 3—Flowsheet of pulverized-coal plant

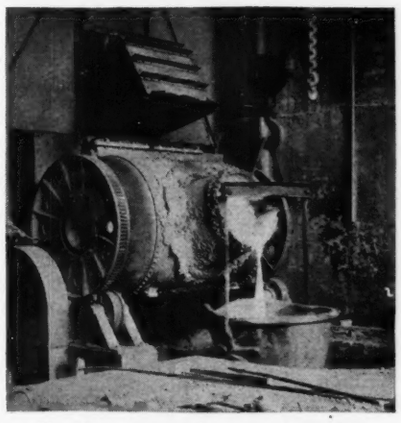
1. 16x12-in. rolls, driven by 10-hp. motor.
2. 68 steel buckets, 8x5½ in. 7½-hp. motor for elevator and spiral conveyor.
3. Storage tank, 15 ft. diameter, 25 ft. high. Spiral conveyor, 12 in. diameter.
4. Dryer, 13 ft. 3 in. by 8 ft. 3 in. Capacity 5 tons per hour. Spiral conveyor, 12 in. diameter, both driven by 10-hp. motor.
5. Furnace grate area, 1,258 sq.in.
6. Hardinge mill, 7 ft. x 36 in.; capacity, 5 tons per hour. Driven by 100-hp. motor.
7. Two powdered-coal storage bins; capacity, 25 tons each.
8. Two sets powdered-coal distribution fan and 50-hp. motor. One set for spare.
9. Powdered-coal-fired boiler No. 3. ½-hp. motor for driving air-lock fan.
10. Waste-heat and powdered-coal-fired boiler No. 2.
11. Waste-heat boiler No. 1.
12. Steel chimney, 10 ft. 9 in. inside diameter, 150 ft. high, 10 ft. diameter, inside firebrick lining.
13. Two sets auxiliary air fan and 22-hp. motor. One set for spare.
14. Powdered-coal-fired refinery furnace on left; hand-fired or powdered-coal-fired on right.

Primary crushing reduces the ore in two stages to a ⅜-in. mill feed, and 10 per cent of the ore is eliminated by hand picking in this plant.

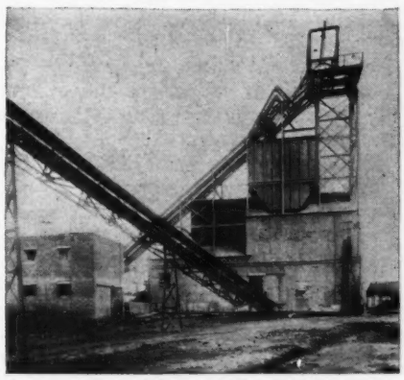
The single-cable tramway conveys the crushed ore to the concentrating mill, at which site the smelter and power house are also situated, a distance of 5½ miles. It crosses the Subarnarekha River with a span of 1,000 ft. This ropeway transports 50 tons per hour with a minimum of trouble and at low cost.

Flow sheets of the concentrating mill and smelter are shown in Figs. 1 and 2, which give full details of individual units and capacities. The concentrating mill operates at high efficiency, giving an average recovery on run-of-mine ore of 96.72 per cent with an annual production of 134,000 tons.

Pulverized-coal-fired reverberatory smelting has been entirely successful, and the reverberatory furnace has now been in continuous operation for over two years without a shutdown for repairs. In waste-heat gases the equivalent of over 3,000 tons of coal per annum in the boiler plant is recovered. Three Stirling boilers supply superheated steam at 11,000 lb. per hour and 290-lb. pressure. Two of these boilers are arranged for either waste-heat or pulverized-coal firing and one boiler is equipped for pulverized-coal firing only. All three boilers are also equipped for auxiliary oil firing to furnish up to 3,000 lb. of steam per hour. The flowsheet of the pulverized-coal plant is shown in Fig. 3. This plant is one of the few such installations operating in India, and is an unqualified success, contributing largely to the low operating costs of the smelter. No undue troubles have been experienced at any time from climatic conditions.



Pouring copper from a converter



Mosaboni mine, main shaft headframe, and primary crushing plant

Three Fraser & Chalmers 625-kw. high-speed multistage impulse-type turbo alternators, with their auxiliary plant, supply the necessary power for all units at the mine, mill, and smelter sites.

A foundry and rolling mill for the fabrication of yellow-metal sheet is a recent addition to the plant, and is now producing a satisfactory grade of sheet for the Indian market. Two-high roughing rolls and three-high finishing rolls have been installed, and no undue difficulties have been experienced in the operation of this plant by native labor.

The foregoing is a brief outline of the activities of the corporation, which is operating the only copper mine in India and producing the only refined copper and yellow-metal sheet manufactured in the country. Present production of the plant is approximately 400 tons (of 2,000 lb.) of refined copper and 300 tons of yellow-metal sheet per month. The plant is designed according to modern American practice, to which all acknowledgments are due and which has contributed largely to our success.

■ ■

Flotation of Hematite a Laboratory Success

A. S. Adams,

S. M. Kobey,

M. J. Sayers

CONCENTRATION of iron ore by flotation has not, to our knowledge, been accomplished commercially, though some preliminary work has been done by the Colorado Fuel & Iron Company, of Pueblo, Colo., and by A. M. Gaudin at the University of Utah. Although nothing is positively known of the success which might be achieved by the flotation of hematite in a large-scale operation, the work here to be described shows that a very real success was obtained in the laboratory. To believe that this process might be applied on a commercial scale is not unreasonable.

The primary requisite of any method of concentration is to show a profit; and in the flotation of iron ores this has been generally accepted as impossible, though a wide margin of profit could be obtained if the concentrate did not require sintering. This cannot be avoided, and minimum milling costs are therefore a necessity.

Present-day blast-furnace requirements demand that the iron content of hematite be at least 58 per cent. To attempt to devise a flotation process for certain kinds of hematite ore for which washing plants and other gravity methods are now successfully applied would be unprofitable, but much material cannot be successfully handled by the methods now in use. The Minnesota Tax Commission carried on its books, on May 1, 1925, approximately 220,000,000 tons of non-merchantable ore which the following work shows could probably be concentrated by flotation at a profit.

Present practice involves beneficiating iron ore by crushing, screening, drying or sintering. In 1914, 9.1 per cent of the iron ore shipped from Minnesota had been concentrated, and the amount had increased to 34.9 per cent in 1925.

At present, a relative abundance of commercial iron ore is in sight, estimated as a supply for twenty to thirty years. Flotation, as a concentrating medium for iron ore, has not been adopted for one or all of the following reasons: (1) The relative abundance of marketable ore. (2) Large initial investment necessary to install flotation plants. (3) The short working period caused by climatic conditions. At the same time, compensating advantages to be gained by the adoption of flotation are: (1) The increased capacity of blast furnaces. (2) The lower mining cost per ton of ore mined. (3) A clean product.

The cost of milling non-ferrous minerals is figured on the basis of unit tonnage treated, but it is more convenient to figure the cost of iron-ore treatment on the basis of unit product because royalties, freight, and other cost items are computed on this basis. The process devised is so simple, and employs reagents of such cheapness, that the following low cost estimate was made for treating washing-plant tailings (17 per cent iron) from the Mesabi range:

	Per Ton Product
Fine grinding	$0.30
Flotation and classification	0.50
Filtering	0.10
Reagents	0.40
Total	$1.30

These figures are approximate averages, based upon laboratory work, and should be reduced considerably in plant practice. The material on which the costs are based is more difficult and expensive to treat than any other concerning which data are available.

The test work here to be described was carried out in the experimental plant of the Colorado School of Mines. Careful attention was given to the maintenance of standard conditions in each test. The first step was to grind the ore in the laboratory rod mill for a measured interval of time. Second, the pulp was transferred to a laboratory flotation machine and diluted to four parts of water to one part of ore. Third, reagents were added in accordance with the following data, and the pulp was aërated for ten minutes with regular removal of froth every fifteen seconds during this time. Finally, the concentrate and tailing were filtered, dried, weighed, and sampled. Analytical determinations were then made on the samples taken. The feed in all tests quoted was Mesabi washing-plant tailing, analyzing 17 per cent iron.

In determining the effect of various conditioning reagents on grade and recovery, sodium carbonate proved the best, followed in order by potassium carbonate, and sodium acid carbonate; of the inferior reagents there was little to choose among calcium carbonate, ammonium carbonate, and sodium hydroxide. Sodium carbonate (soda ash) is also economical and easily available; 2 lb. per ton seemed to be adequate, this giving a concentrate containing 57 per cent iron, with a recovery of 67 per cent. For frothing and collecting, 1 lb. of oleic acid was added in 10 per cent alcoholic solution, per ton of ore.

In the second test the variable was the frothing and collecting reagent; the conditioning reagent was constant at 2 lb. of sodium carbonate per ton. Oleic acid, emulsified oleic acid, sodium oleate, and fish oil were tried, and all gave about the same grade of concentrate, in general from 55 to 59 per cent. Neither was the recovery greatly different, though optimum results were indicated with either oleic acid or sodium oleate, to the amount of 2 or 3 lb. per ton, giving 66 to 71 per cent recovery.

The criterion for determining which of the two, oleic acid or sodium oleate, is the more suitable for practical use is fundamentally one of cost. Each of these reagents must be thoroughly dispersed in the pulp. Such dispersion can be effected with sodium oleate by simple mechanical mixing, but for best results oleic acid should be dissolved in a solvent which is itself miscible with water. The results of such a solution were entirely satisfactory.

Among the solvents tried, either methyl or ethyl alcohol proved the most suitable for the purpose. Tests were made with various percentages of oleic acid dissolved in alcohol, gasoline, and blast-furnace fore-runnings, the amount of soda ash being constant as before, at 2 lb. per ton, and of oleic acid at 1 lb. per ton. These tests showed that the grade of the concentrate held at about 56 per cent, regardless of the relative amount of oleic acid and solvent alcohol, the recovery also averaging about 56 per cent, though a solution of 90 per cent alcohol and 10 per cent oleic acid gave optimum results, with a grade of 57 per cent and a recovery of 67 per

cent. Blast-furnace fore-runnings were somewhat better than gasoline, both to grade and recovery of concentrate.

Deflocculation and dispersion being important in achieving success, tests were made with various concentrations of sodium silicate. Without any of this reagent, the grade and recovery were respectively 57 and 67 per cent; using ½ lb. of sodium silicate per ton gave 58 and 62 per cent respectively; 1 lb., 60 and 58 per cent; 2 lb., 62 and 48; and 3 lb. 61 and 26 per cent, this amount affecting the recovery very seriously. As small amounts do improve the grade to some extent, a little sodium silicate might profitably be employed in a cleaner cell.

Proper dispersion may also be affected by the temperature of the pulp, so tests were next conducted with variations of 10 deg. C. from 10 to 50, using 2 lb. sodium carbonate per ton as conditioner, and 1 lb. per ton of several frothing and collecting agents, including oleic acid in alcoholic solution (90 per cent alcohol), oleic acid, sodium oleate, and fish oil. In general, the grade of the concentrate was the highest when the pulp was at 20 deg. C., though a slightly higher grade was obtained at 10 deg. with sodium oleate. The grade dropped off rapidly with increased temperature, but the recovery coincidently improved; the pulp then seemed very soapy, with a copious froth that exhibited but little selective action. Recoveries were very poor with the pulp at 10 deg., probably owing to incomplete dispersion of the fatty-acid globules. In general, 20 deg. seemed to give the best conditions, considering both grade and recovery.

Several authorities have maintained that reagent cost is lessened if flotation is carried on in a dense pulp, especially when fatty acids, of which oleic acid is one, are used as the frothing agent. As this acid was the most effective frothing agent used in this work, determination of the optimum pulp density was the logical object of the next test. The reagents used were the same as in the previous test, and the temperature of the pulp was maintained at 20 deg. With 12½ per cent of solids in the pulp, the grade of the concentrate was 37 per cent and the recovery 35 per cent; with 25 per cent solids, 57 and 67 per cent respectively; 37½ per cent, 58 and 63; and 50 per cent solids, 58 and 57 per cent. The best density therefore is evidently 25 or 37½ per cent solids.

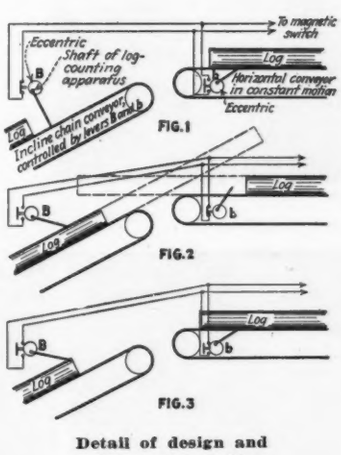
Fine-grinding is expensive, and as 78 per cent of the ore as received was minus-150 mesh, the next tests were conducted to show how much additional grinding was advisable. Samples were run without additional grinding, with five minutes' grinding, and after ten minutes' grinding. The percentage of iron recovered in plus-200-mesh particles was 20 per cent after ten minutes' grinding, compared with 22 per cent without any grinding whatever, but the total recovery was much better with the ten-minute grinding period, being 67 per cent, compared with 50 per cent with five minutes' grinding, and 32 per cent with no grinding at all. The desirable size of this ore, to get maximum recovery, would be minus-200 mesh.

In conclusion, the work described in the foregoing has demonstrated that hematite ore from the Mesabi range, as found in washing-plant tailing, can be effectively concentrated by flotation in the laboratory. Optimum conditions have been determined for the consistent production of a hematite concentrate analyzing 59 per cent iron, with a recovery of 74 per cent of the iron in the feed.

Automatic Log Conveyors

ADJACENT to the smelter of the Compagnie Du Boleo, at Santa Rosalia, Baja California, is the company's sawmill, where an interesting and efficient method is employed for mechanically conveying floating mine timber from the harbor to the mill, which is about 30 ft. above sea level. From an incline chain conveyor leading out of the water, the 6-in. logs fall onto a horizontal conveyor and are slowly fed to the saw, where they are cut according to specifications of the mines department.

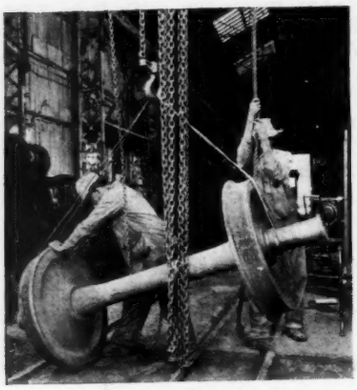
With hand-controlled conveyors, constant trouble was experienced at the point where the incline conveyor discharges to the horizontal conveyor, because operators would feed the logs to the incline conveyor faster than they could be sawed. This resulted in hopeless congestion, with consequent damage to the conveyors, besides requiring numerous operators to supervise this phase of the work. To simplify operations and make them dependable, A. Froger and P. Perrin, chief electrician and assistant electrician respectively, developed and perfected a scheme of automatic control, whereby the incline conveyor is stopped instantaneously at the first indication of congestion at the transfer point. As indicated in the accompanying sketches, this is accomplished by the flap-like levers *B* and *b*, each of which is attached to a small eccentric that actuates a push-button switch connected in parallel to a magnetic switch.

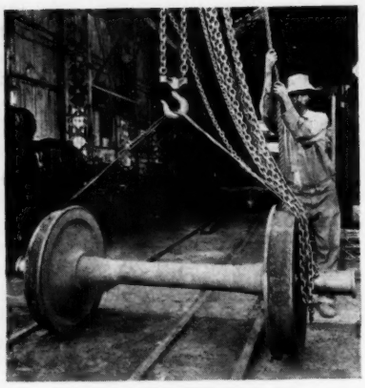


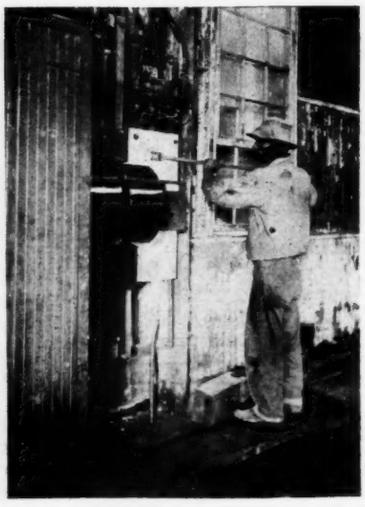
Detail of design and scheme of operation

The operating procedure is as follows: A moving log on the incline conveyor raises the lever *B*, the attached eccentric disconnecting the switch *B*, as indicated in Figs. 1 and 2. This action would stop the conveyor were it not for the release of lever *b* some moments before by the advancing log on the horizontal conveyor, thus closing switch *b*, as shown in Fig. 2. Assuming that the horizontal conveyor is crowded to capacity, with switch *b* pressed open by the weight of the last log, the incline conveyor is stopped the moment lever *B* is raised by the following log; this disconnects switch *B*, as illustrated in Fig. 3. An automatic counting apparatus is attached to the shaft of lever *B*, the ratchet-like movement of which, effected by the passing logs, actuates the counting mechanism.

PREVENTING ACCIDENTS *by Pictor*

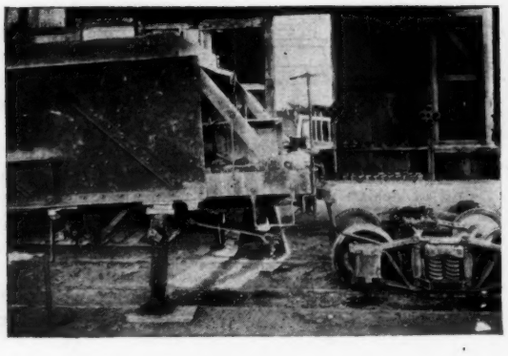


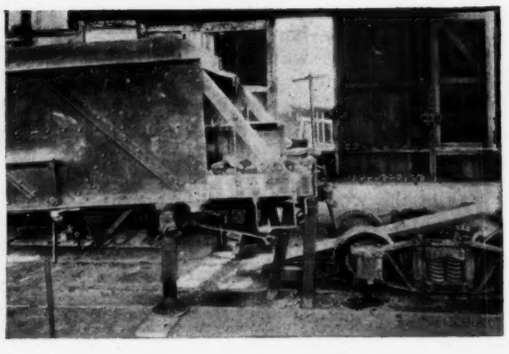




▸ Plant photographs, depicting hazardous methods in contrast to evidence of caution and care, prove an effective means of educating employees of the Moctezuma Copper Company, a subsidiary in Mexico of the Phelps Dodge Corporation

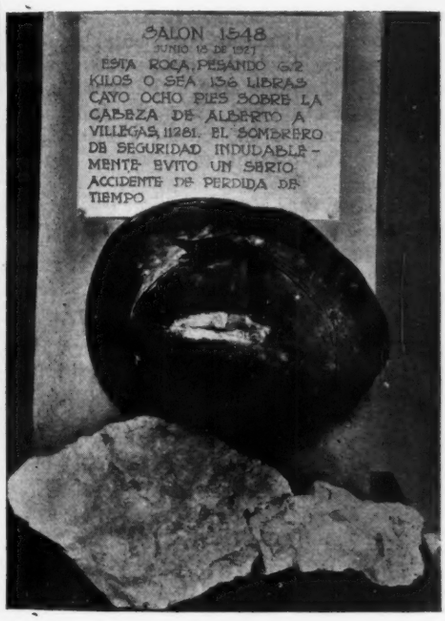
PARRILLA DE LA BOLSA DEL 1200
El Sr. Dn. Ramón M. Tonori (ficha 8977) al estar quebrando piedra con marro, evitó un accidente de pérdida de tiempo, en el que probablemente hubiese perdido el ojo a no ser por las ANTIPARRAS, pues el fragmento de mineral únicamente penetró la rejilla, sin tocar para nada el ojo.





Comparison of Safe and Unsafe Practice

▸ The pictures tell the whole story. Through them, any worker, speaking any language, can soon acquire a knowledge of procedure in his particular job that should prevent accidents to himself, as well as to his fellow workers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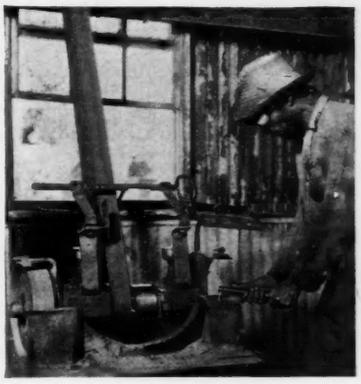
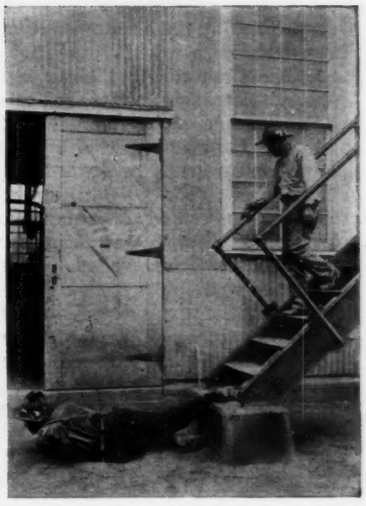
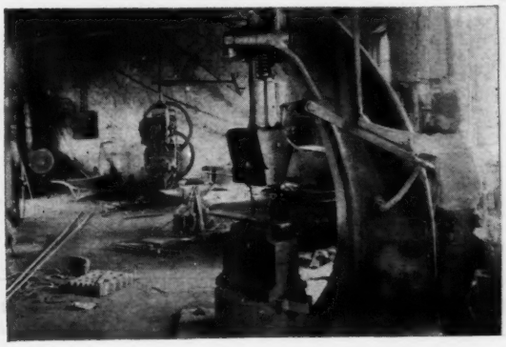
ESTA ROCA, PESANDO 62 KILOS O SEA 136 LIBRAS CAYO OCHO PIES SOBRE LA CABEZA DE ALBERTO A VILLEGAS, 11281. EL SOMBRERO DE SEGURIDAD INDUDABLEMENTE EVITO UN SERIO ACCIDENTE DE PERDIDA DE TIEMPO







Geology and Origin of the Phosphate Deposits of Tennessee

Richard W. Smith

THREE distinct varieties of phosphate rock occur in Tennessee. They are known commercially as: (a) the "brown" rock, which is the residual product of the weathering and natural concentration of certain phosphatic Ordovician limestones; (b) the "blue" rock, an unaltered phosphatic stratum of Mississippian age; and (c) the "white" rock, which is the result of chemical replacement and deposition. The white rock is of little economic value and will not be considered here.

Tennessee may be divided into six physiographic divisions (see Fig. 1), as follows:

1. The Appalachian Mountains, a narrow mountainous border on the eastern edge of the State, the highest ridges forming the boundary with North Carolina. The white phosphates of Johnson County lie within this division in the northeast corner of the State.

2. The Great Valley of East Tennessee, drained by the Tennessee River and its tributaries.

3. The Cumberland Plateau, a broad elevated plateau forming a belt 50 miles wide extending entirely across the State.

4. The Highland Rim, a broad peneplain sloping gently westward from an elevation of about 1,000 ft. at the foot of the Cumberland Mountains to an elevation of 600 to 800 ft. near the western Tennessee River valley. It derives its name from the fact that it entirely surrounds the oval depression of the Central Basin or "Blue Grass" region of Tennessee. The edges of the rim surrounding and overlooking the Central Basin, and the part just east of the Tennessee River in Hardin, Wayne, Perry, and adjoining counties, are well dissected by streams into steeply rounded hills and spurs. Tennessee's blue phosphate deposits underlie the eastern portion of the Western Highland Rim, in Hickman and parts of Lewis and Maury counties. The deposits outcrop along the sides of the narrow valleys of the streams, such as Swan Creek, that have dissected this portion of the rim. The white phosphate deposits occur along the western edge in Perry and Decatur counties.

5. The Central Basin, an oval-shaped depression 50 to 60 miles in width and about 100 miles long, drained by the Cumberland, Harpeth, Duck, and Elk rivers and their tributaries. Murfreesboro is a few miles southeast of the center of the basin, and Nashville is situated near its northwestern margin. It has a gently rolling surface, the result of stream erosion and solution on limestones. The rocks dip gently in all directions from the center. The outer margin of the basin is very irregular and crenulated, owing to the headwater erosion of streams that are eating into the surrounding Highland Rim and enlarging the basin. Extending well out into the basin from this margin are numerous erosional remnants or outliers of the Highland Rim, in the form of knobs, typically developed in parts of the brown phosphate region, and narrow ridges, such as those separating the various brown phosphate districts. The brown phosphate deposits occur along the entire western side of the Central Basin, but the principal deposits are found in the valley of Duck River and its tributaries, in Maury County. The physiographic history of the Central Basin and its influence on the formation of the brown phosphate deposits will be described later.

6. The West Tennessee Plain, a part of the Mississippi embayment area, which slopes gently westward from an elevation of from 500 to 700 ft. along the Tennessee River, to 300 to 400 ft. at the margin of the Mississippi flood plain. Its surface is gently rolling and drained by a number of streams that head near the Tennessee River and flow westward into the Mississippi.

The geologic and physiographic history of Middle Tennessee can be divided into two periods: (1) a long period, the whole of the Paleozoic era, of deposition of sedimentary rocks, mostly limestones, in shallow continental seas that oscillated over the area, sometimes covering the whole area and sometimes only a part of it; and (2) a still longer period, from the end of the Paleozoic era until the present, of elevation and erosion.

Elevation has not been equal over the whole area, but has resulted in the region having the structure of a dome, with the rocks dipping gently on all sides from a center near Murfreesboro. Neither has the elevation been a gradual one. It has taken place in steps, followed by long periods of quiet in which the streams have been able to erode their valleys almost to base level, forming broad peneplains. One of these peneplains forms the Highland Rim, and once extended over the Central Basin. The hard rocks that form the surface of the Highland Rim were

This article is based on a thesis "The Geology and Origin of the Brown and Blue Phosphate Rock Deposits of Tennessee," presented to the faculty of the graduate school of Cornell University for the degree of Master of Science. It is published with the permission of the Tennessee Geological Survey.

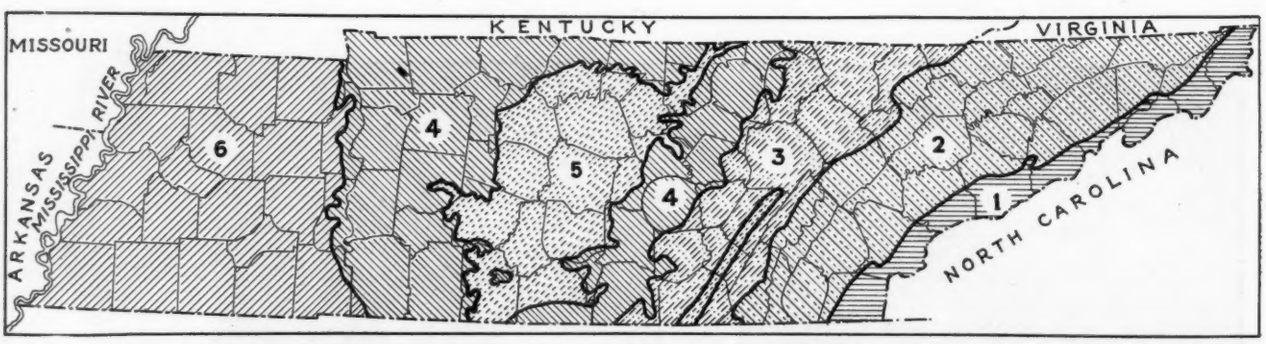


Fig. 1—The physiographic divisions of Tennessee: (1) Appalachian Mountains; (2) Great Valley of East Tennessee; (3) Cumberland Plateau; (4) Highland Rim; (5) Central Basin; (6) West Tennessee Plain

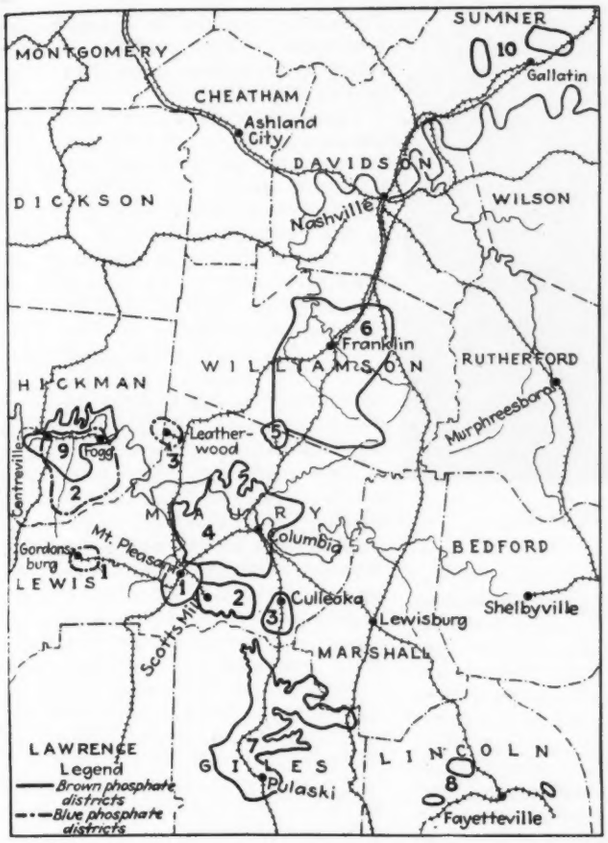


Fig. 2 — Sketch map showing the phosphate - producing districts of Tennessee

worn through at the center of the dome, exposing the more easily eroded Ordovician limestones. These in the following stages formed a basin, small at first, but gradually enlarging to the present Central Basin. The last stage, known as the Central Basin Peneplain, formed the level center of the basin and the broad valleys on its western edge that are underlain by the brown phosphate.

For convenience the brown and blue phosphate deposits of Tennessee may be divided into geographical districts or "fields," as they are often called. One must bear in mind, however, that, although these districts are sometimes partially separated by natural boundaries, such as ridges that interrupt the continuity of the deposits, they often represent somewhat artificial divisions, which, in many instances, connect with one another directly without complete interruption. (See Fig. 2.)

The brown phosphate occurs on the western side of the Central Basin in the following districts (see Fig. 2): (1) Mount Pleasant district, a small area near Mount Pleasant, in Maury County, from which the greater part of the production of phosphate rock from Tennessee has come. (2) Scotts Mill and Southport district, east of the Mount Pleasant district, in Maury County. (3) Culleoka district, a small area to the east of the Scotts Mill and Southport district, in Maury County. (4) Columbia district, a large area in the center of Maury County. It includes the following subdivisions or areas: Bigbyville and Pulaski Pikes area south of Columbia; Hampshire and Williamsport Pikes area west of Columbia and south of Duck River; Godwin and Darks Mill area, north of Duck River and Columbia; and the Bear Creek area, northeast of Columbia. (5) Spring Hill district, a small area west of Spring Hill, in the northern part of Maury County. (6) Franklin Quadrangle district, including several small, scattered areas in Williamson County. (7) Giles County district, including the following subdivisions or areas: Wales and Pigeon Roost Creek area, along Richland and Pigeon Roost creeks, north of Pulaski; Buford, Deray, and Brick Church area, further up the valley of Richland Creek, in the northern part of the county; and Elkton-Prospect area, in the southern part of the county. (8) Lincoln County district, including several small, scattered areas in Lincoln County. (9) Centreville district, comprising the brown phosphate areas of Hickman County. (10) Sumner County district, including several scattered areas.

The center of the basin has no phosphate deposits, because the rocks outcropping there are stratigraphically lower than the phosphatic horizons. Its eastern edge contains no deposits, because the phosphatic horizons are absent, or, if present, their character has changed so that they are not phosphatic limestones.

Blue phosphate occurs only in Hickman County and adjoining portions of Lewis and Maury counties. The deposits may be divided into the following districts: (1) Gordonsburg district, on upper Swan Creek, in Lewis County. (2) Swan Creek district, the valley of Swan Creek and its tributary branches from the Hickman-Lewis county line to Duck River, and Indian Creek south of Centreville. (3) Leatherwood district, a small area along Leatherwood Creek, Dry Prong, and Leipers Creek, in Hickman and Maury counties.

The brown rock phosphate deposits of Tennessee are the product of the residual weathering of the phosphatic limestones of the Bigby, Cannon, Leipers, and Hermitage formations of Ordovician age. The terms "phosphate," "rock phosphate," or even "rock," are used in the brown phosphate districts to include both the coherent plates of calcium phosphate, called "lump rock," and the relatively abundant quantities of loose, rounded grains of the same material, called "phosphate sand," always found associated with the lump rock. More or less clay is always associated with the phosphate sand, and a mixture of these two materials is locally called "muck." Some deposits are largely muck, and contain little or no lump rock. The usage of these terms is so common in the brown rock phosphate industry of Tennessee that they will be retained in this article.

The term "brown phosphate" is applied to all the phosphate derived from the weathering of phosphatic Ordovician limestones, regardless of its true color, which may vary from white to a dark brown. In texture, the lump rock may vary from a soft chalky mass through a porous, loosely coherent rock, to a hard, tough one, sometimes dense and sometimes with a porous or "honeycomb" texture. Typical brown lump rock phosphate is a loosely coherent, porous, rusty-brown rock, usually in

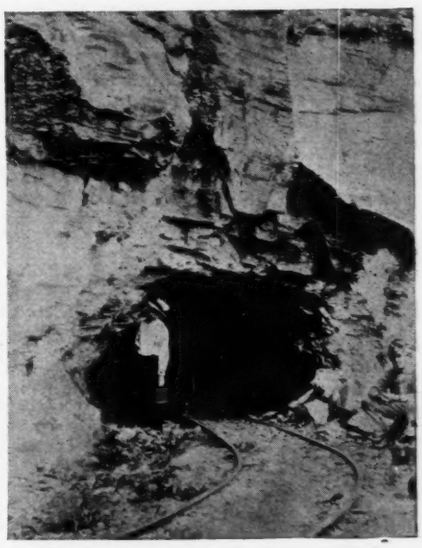


Fig. 3—Portal of haulage drift of a blue phosphate mine at Gordonsburg, Tenn. The phosphate layer, overlain by chert, is seen under the man's foot.

Fig. 4—Mining a blanket deposit of brown phosphate near Mount Pleasant, Tenn.

loose plates that rest on one another or on thin layers of muck. The lump phosphate from the Bigby, Cannon, and Leipers formations cannot usually be distinguished lithologically, but that from the last two is often coarser grained and more porous than that from the first. It sometimes shows the impressions of fossils such as brachiopods that were in the original limestone. Bigby lump phosphate rarely ever shows any trace of large fossils. Casts or internal molds of *Cyclora,* the tiny coiled embyro of numerous species of gastropods, are common in all the brown phosphates.

Chemically, phosphate rock may be considered, aside from its impurities, as the normal tricalcium phosphate of lime, with the formula $Ca_3(PO_4)_2$. Actually, it consists principally of the mineral collophane, often accompanied by dahllite. Collophane is an amorphous calcium carbono-phosphate of rather indefinite chemical composition, and dahllite is a fibrous, hexagonal calcium carbono-phosphate mineral. Impurities in the phosphate are silica, iron, alumina, and fluorine. The analysis presented in Table I, by D. F. Farrar, chemist, Tennessee Geological Survey, is typical of the average commercial brown rock phosphate of Tennessee.

Table I—Typical Analysis of Brown Rock Phosphate

	Determined, Per Cent	Probable Combination, Per Cent
Insoluble	2.64	2.64
Fe_2O_3	1.76	1.76
Al_2O_3	2.14	2.14
CaO	48.73	.....
P_2O_5	34.32	.....
$Ca_3(PO_4)_2$	.....	74.95
CO_2	4.06	.....
$CaCO_3$	.....	9.22
F	2.00	.....
CaF_2	.....	4.10
H_2O	5.37	5.37
Total	101.02	100.18

Phosphate deposits, lump rock and muck, occur as a "blanket" of varying thickness overlying the phosphatic limestone, flat where the limestone has a flat surface, but dipping sharply down into the "cutters" or drainage channels frequently found in the limestone. Over this blanket of phosphate is a varying thickness of overburden, composed of clay, chert, and soil. The problem of the origin of these deposits of brown residual phosphate resolves itself into two parts: (1) the source of the phosphate in the phosphatic limestone; and (2) the process of the leaching and transformation of these limestones into the residual brown phosphate deposits.

Tennessee phosphatic limestone is usually a dense bluish granular to crystalline rock, often banded with thin dark-blue to black layers which are more phosphatic than the rest of the rock. The lighter bands are somewhat crystalline, and contain an abundance of small shell fragments. The darker or more phosphatic bands are granular or sub-oölitic in texture, and often show the phosphatic casts or internal molds of *Cyclora.* On fresh surfaces the limestone is massive, but on weathered surfaces the laminated, strongly cross-bedded character is plainly shown. The Bigby limestone of the Mount Pleasant district, with the exception of a bed near the top of the formation, does not usually contain large shells, but the Bigby of other districts and the phosphatic Cannon and Leipers limestones often contain brachiopods, gastropods, and bryozoa. In the smaller phosphate districts the phosphatic limestones are often much less banded, laminated, and cross-bedded than that of the Mount Pleasant, Columbia, and Centreville districts.

The phosphate content of the limestones varies considerably. Bigby limestone of the Mount Pleasant district and parts of the Leipers limestone in the Centreville district average from 15 to 20 per cent $Ca_3(PO_4)_2$, although the darker streaks often contain more than 40 per cent. Away from the Mount Pleasant district, the Bigby becomes less phosphatic. The Cannon limestone rarely ever contains more than 10 per cent of $Ca_3(PO_4)_2$.

Usually, the presence of much phosphate in a limestone can be detected by the presence also of small highly polished oval grains having a brown color on weathered surfaces, but a dark-blue to black color in the blue unaltered limestone. The more abundant these rounded grains in the limestone, the greater is the proportion of the phosphate which it contains.

The source of the phosphate in the phosphatic limestones has been considered by previous writers to be the remains of marine animals that secreted shells of calcium phosphate instead of calcium carbonate. My petrographic investigations do not confirm this theory. The phosphate, aside from a small amount present as interstitial filling and a few small nodules, was replacing the calcium carbonate of small fragmental bryozoa and perhaps crinoid stems. All stages in the replacement were represented, from all calcite, through partial replacement, sometimes destroying the fossil structure but often preserving it, to complete replacement of the entire fossil by the collophane. In the darker bands of the limestone the replacement was more complete than in the lighter bands.

I am therefore forced to conclude that the phosphate in the sea water was precipitated on the sea bottom by some biochemical or physico-chemical agency, along with the calcareous shells and remains of the animals living in the sea; and that, although the sediments were still soft and unconsolidated, the phosphate thus precipitated partly replaced some of the calcareous fossils.

The brown rock phosphate deposits of middle Tennessee are the result of the weathering and leaching of the phosphatic Ordovician limestones. This weathering has been going on since the middle of the Pliocene period, when the Central Basin was eroded to nearly its present size, and the surface worn down until the phosphatic limestones were exposed. When such a phosphatic limestone is subjected to weathering by

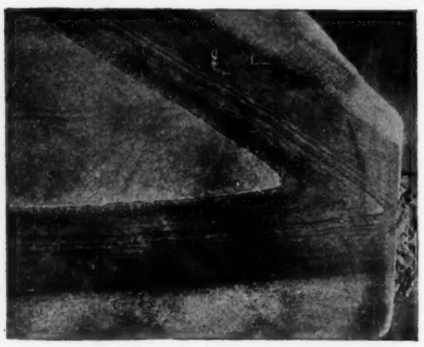


Fig. 5—Slab of compact blue phosphate showing weathering inward from joint planes that has formed brown bands and a gray border.

acidulated ground waters, charged with carbon dioxide from the atmosphere and from decaying vegetable matter, as well as the humic acids of the soil, the calcium carbonate is carried away in solution, leaving behind the more insoluble calcium phosphate, as well as the impurities. The extent to which such a weathering takes place depends on the following factors: (1) position of the phosphatic limestone strata relative to surface topography; (2) abundant jointing of the rocks, affording channels for the rapid circulation of underground waters; (3) favorable surface and underground drainage conditions; (4) character of the underlying and overlying beds; (5) presence of clay seams in the limestone; (6) character of the ground water.

The position of the phosphatic limestone strata relative to surface topography is of utmost importance. Three conditions may result:

1. If the phosphatic limestone is buried so deeply by the overlying beds that weathering cannot reach it, no further enrichment of the phosphate is, obviously, possible.

2. If the phosphatic limestone lies in a bed too far from the tops of the hills to be completely exposed to surface weathering, but only outcrops and is weathered in a narrow band around the sides of the hills, a deposit encircling the hills but not reaching to the tops is formed on this outcrop. Such a deposit is called a "rim," "hatband," or "collar" deposit.

3. If erosion has removed the overlying rocks so that the phosphatic limestone itself forms the surface rock over considerable areas, weathering can extend deeper owing to underground drainage of the ground water, and the areal distribution is not confined to a limited narrow outcrop. Such deposits are often extensive, covering a gently sloping or rolling terrace or the crown of a low hill, and are known as "blanket" deposits.

During the Central Basin peneplanation stage of the development of the basin, the elevation of the Nashville Dome ceased for a while and the streams enlarged their valleys by meandering. In the Mount Pleasant and Columbia districts, and to a limited extent in other regions, this erosion removed the overlying formations from large areas of the phosphatic limestone, which has since weathered into the rich blanket deposits that have furnished the greater part of Tennessee's phosphate production.

Another important factor in the formation of the brown phosphate deposits is the abundant jointing of the limestones, caused by fracturing as they were elevated to their present position and bent into the minor undulations. These joint planes form the principal avenue of descent of the acidulated ground water into the phosphatic limestone. Hayes and Ulrich[1] state that capillarity is chiefly responsible for the movement of the waters, the flow in wet weather being chiefly downward and outward from the joint planes into the bedding planes of the limestone. In dry weather the flow may be reversed. This circulation gradually enlarges the joint planes by solution of the calcium carbonate of the limestone and enrichment of the calcium phosphate, until they become, in many instances, large underground water channels carrying the water for long distances to the creeks. In this way the so-called cutters are formed. (See Fig. 6.) These are long, narrow trenches in the limestone filled with the residual brown phosphate. If the phosphate left is platy, the original structure is preserved in the phosphate filling the cutters. In all except the small, incipient cutters, the layers of phosphate sag downward into the cutter owing to the removal of the calcium carbonate content of the original limestone. In the Mount Pleasant field, these cutters are pronounced in their development. In almost any of the larger pits where the phosphate has been mined may be seen the long narrow trenches, separated by the intervening walls of fresh limestone which are irregularly traversed by smaller cross cutters. Where the cutters are numerous, the narrow pinnacles of limestone between are called "horses."

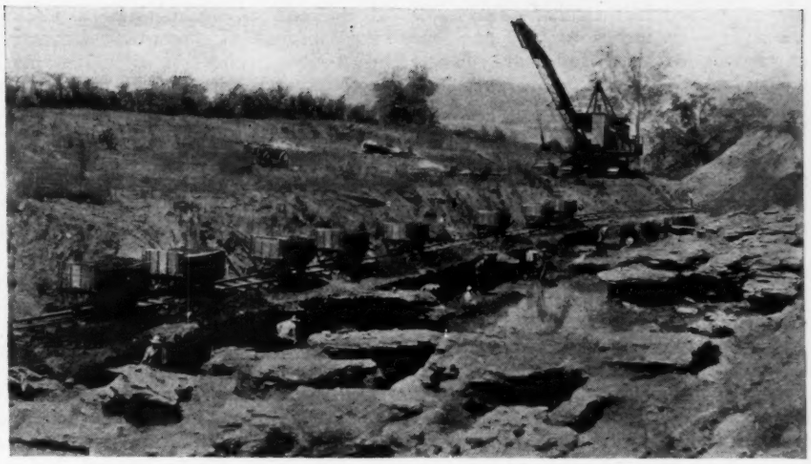


Fig. 6—Small "cutters" and "horses" in a brown phosphate mine at Mount Pleasant, Tenn.

Descriptions of the process of weathering and bleaching of the phosphatic limestone to brown phosphate give the impression that the principal change involved is the solution and removal of the calcium carbonate, and that the brown phosphate is merely the residual phosphate in place.

My petrographic examination of the phosphatic limestones and brown phosphates has convinced me that the process of replacement of the calcium carbonate by calcium phosphate during the weathering and leaching process is of prime importance. The thin sections of the phosphatic limestone show that even in the darker and more phosphatic bands the phosphate is not present in sufficient quantities to leave a coherent mass if the calcite were leached out. The result of simply a removal of the calcite would be a loose phosphatic sand. Thin sections of the ordinary brown lump phosphate show a decided spherule or ovule structure, with many of the spherules showing the structure of small bryozoa and other fossils. These spherules, and usually the material that cements them, are composed of light-yellow to brown collophane, and are more or less spotted with iron oxide stains. Holes or pore spaces are common in the porous lump rock, and the holes are sometimes lined or partly filled with an orange-colored fibrous phosphate mineral, probably dahllite.

Dahllite, as rather indefinite isolated fibers in the collophane spherules and groundmass, and as a thin line of fibers around the spherules, is sometimes found. Occasionally the groundmass contains a little fluorite, showing that all of the fluorine reported in the chemical analyses may not be in combination with the phosphate. A few grains of detrital quartz are always present. Silica, plainly deposited from solution, is often found in the interstices between the spherules, and sometimes replacing the fossiliferous collophane spherules.

Water that leached out the calcium carbonate evidently contained phosphate in solution, derived from percolating through the overburden and the brown phosphate overlying the limestone. Leaching of the limestone and enrichment of the phosphate always progresses completely; that is, no gradual gradation exists between phosphatic limestone and brown phosphate. The line of demarkation is always sharp: on one side phosphatic limestone of the usual type, on the other brown phosphate with no remaining calcite. It may even pass through a fossil, making half of it

[1] Hayes, C. W., and Ulrich, E. O.: U. S. Geological Survey Geological Atlas, Columbia Folio, No. 95, p. 6, 1903.

phosphate and half calcite. The outer three or four inches of the limestone surface is oxidized to a gray-brown color, but its carbonate and phosphate content is no different from the fresh blue limestone.

The blue phosphate rock is an unaltered phosphatic portion of the Hardin sandstone member of the Chattanooga shale of basal Mississippian age, occurring in Hickman, Lewis, and Maury counties, underlying the edge of the Highland Rim on the southwestern side of the Central Basin. It varies in thickness from a few inches to 3 or 4 ft., and, in composition, ranges from a somewhat phosphatic shale or sandstone to a highly phosphatic, sometimes oölitic-looking, rock. The blue phosphates have been classified as follows: (1) shaly phosphate; (2) conglomeratic phosphate; (3) oölitic phosphate; (4) compact phosphate. The shaly and conglomeratic varieties are too low grade to be of economic value. They are shales, sandstones, and conglomerates containing a varying phosphatic content up to 45 or 50 per cent of calcium phosphate, and represent the gradations between the commercial blue phosphates and the ordinary Hardin sandstone.

The oölitic and compact varieties may contain up to 75 per cent calcium phosphate, with a general average of 65 per cent. They differ from each other mostly in fineness of grain. The oölitic structure of the former is caused by collophane spherules, large enough to be visible to the naked eye. These ovules are bluish-black or gray and have a polished or glazed surface. The color of the rock varies from a light gray to a dark blue, the latter being the most common. The compact variety is a dark-gray or blue color, and resembles a fine-grained, homogeneous sandstone or limestone. Spherules are hard to distinguish even with a hand lens.

A petrographic study of thin sections of these varieties shows them to be composed almost entirely of the collophane spherules, more or less stained with spots of organic matter, some of which are curved rods and branching hair-like forms. Other spherules are not homogeneous, but are rounded pebbles containing portions of smaller spherules cemented by collophane or chalcedony. Only one small spherule was seen that had the concentric structure of a true oölite. Occasional conodonts and other queer-shaped fossil fragments composed of clear yellow collophane are found. In the oölitic variety the spherules are coarse and are cemented by mixtures of collophane, fibrous dahllite, organic matter, pyrite, and sometimes chalcedony. In the compact variety the spherules are smaller and are packed closer together, cemented usually by collophane.

Microscopic examination reveals that the gray color of some of the oölitic type results from the absence of most of the organic matter staining the grains and in the cement. Sometimes a bed of blue phosphate of good grade is overlain by a few inches of a much more siliceous and lower-grade rock, called "skull rock" by the miners. This is chiefly caused by a replacement of the cementing material of the top layer by quartz and chalcedony, although it sometimes contains detrital quartz grains and resembles the conglomeratic variety.

The oölitic variety weathers to the appearance of a rusty, porous sandstone, and the compact variety to a dense brown phosphate rock. Weathering proceeds inward evenly from the exposed surfaces and from the joint planes that are open enough to allow water to seep through. The brown portions are streaked with straight narrow darker-brown bands, parallel to the weathering face, having the appearance of stratification planes. These result from the deposition of iron oxide, formed largely by the weathering of the pyrite. Often this weathered brown portion is separated from the fresh blue rock by a narrow light-gray band. (See Fig. 5.) This is caused, according to Hayes[2], by the removal of the carbonaceous matter, and with it the dark color, first, oxidation of the iron following later.

Evidently the Mississippian blue rock phosphate is an unaltered bedded deposit, and, unlike the Ordovician brown rock phosphate, is not a product of surficial weathering and enrichment. Such a deposition of a sediment composed almost entirely of calcium phosphate is not common and at first sight would appear difficult of explanation. The generally accepted theory that the blue phosphate rock resulted from a reworking and deposition of ancient brown rock deposits formed by the leaching and weathering of the Leipers phosphatic limestone during the long interval between the Silurian and the Mississippian periods is probably correct in its major points. My study of thin sections of the rock confirms the theory, as many of the collophane spherules showed the structure of the small bryozoa so common in the Ordovician phosphates and phosphatic limestones. These and the *Cyclora* are always much rounded. In addition, some of the spherules are made up of parts of previous smaller spherules, the missing parts being worn off in the rounding of the larger grain, often cemented by chalcedony, as sometimes prevails with the brown phosphate.

The presence of much organic matter in most of the blue phosphates suggests that they were deposited in rather stagnant water conditions and perhaps in a cool climate, as has been suggested for the deposition of black shales containing organic matter. This organic matter, acting as a reducing agent, is probably the cause for the presence of the pyrite commonly found in the blue phosphate.

My conclusions therefore support the generally accepted theory of the origin of the blue phosphate, but not that of the origin of the brown phosphate. I consider the source of the phosphate in the phosphatic limestones not to be the shells of phosphate secreting animals, but some bio-chemical precipitate of amorphous phosphate on the sea bottom, and, while still soft and unconsolidated, a partial replacement of some of the calcium carbonate shells. I consider the process of the formation of brown phosphate from these phosphatic limestones not to be the mere solution of the calcium carbonate, leaving the skeleton of calcium phosphate behind, but also a continuation of the replacement process, so that the structures of the original calcium carbonate fossils are often preserved in the brown phosphate.

[2] Hayes, C. W.: "The Tennessee Phosphates." U. S. Geological Survey, Seventeenth Annual Report, Part 2, pp. 526, 1896.

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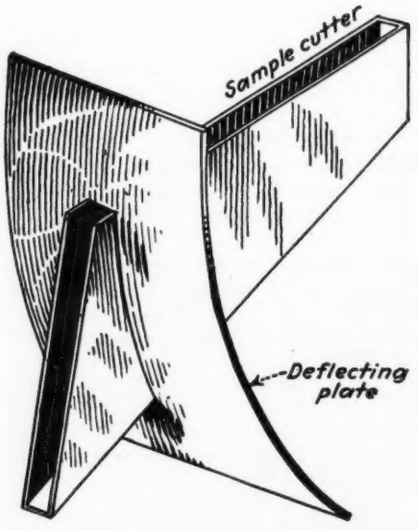
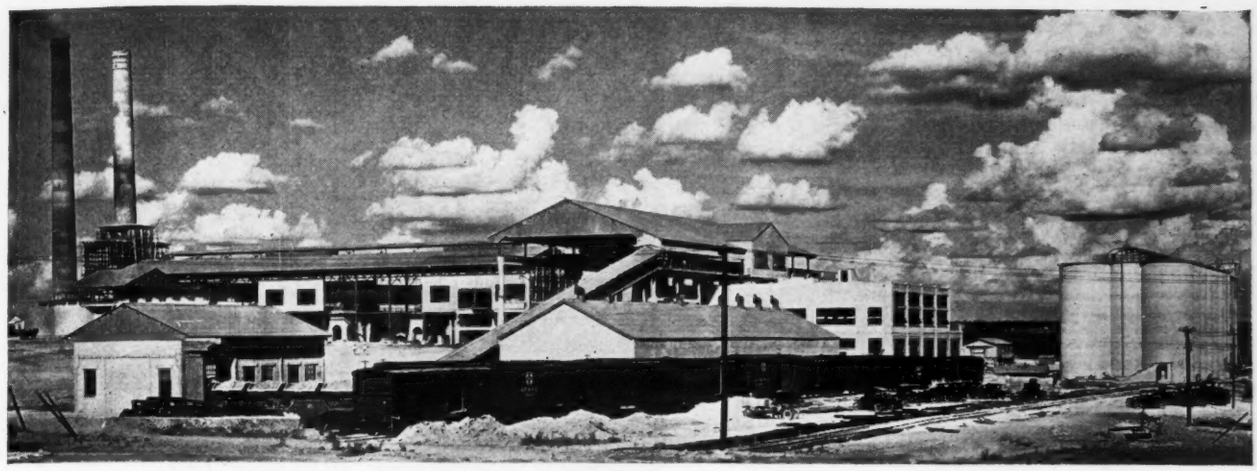
Deflecting Plate for Automatic Sample Cutter

Automatic tailing and pulp samplers usually consist of a narrow trough that is passed through the rapidly moving stream, cutting across its entire section. Inevitably, a certain amount of splashing takes place, and some of this spill is often caught by the sample pail.



To avoid this difficulty, and to insure the accuracy of the sample, a deflecting plate is welded to the cutter in such a position that it will throw aside all spill caused by the movement of the cutter across the stream.



Mining and Processing of Cement Materials

J. B. Nealey

CEMENT making has become one of the world's greatest industries, and the methods and equipment employed have been brought to a high state of efficiency. One of the most modern plants in the cement industry is that of the Republic Portland Cement Company, at San Antonio, Tex., which has a capacity of nearly 4,000 bbl. per day. The site, 8 miles northeast of San Antonio, is 475 acres in extent, and enough raw materials have already been blocked out to make 75,000,000 bbl. of cement. As the overburden is only about a foot deep, quarrying costs are at a minimum. The raw material is soft, argillaceous limestone, running between 30 and 92 per cent calcium carbonate. Much of it, about 80 per cent, is a natural cement rock carrying practically the correct proportions of cement-making ingredients—76 per cent carbonate of lime and 21 per cent silica and alumina. Gypsum, of course, is added, after burning, to regulate the set. This rock occurs in the upper and middle zones of the Austin chalk formation, one of the lower members of the Gulf series of the Upper Cretaceous period, which outcrops in a narrow band from the Red River to the Rio Grande.

Only one working face, 30 to 50 ft. high and 1,200 ft. long, is required in the quarry, as the different grades of rock are found in the exposed strata. The high- and low-lime rock beds are at the ends, and the natural cement rock is in the middle. The character of the natural cement rock varies within narrow limits, the maximum change in grade not exceeding 2 per cent. In quarrying the rock, the practice is to keep the calcium carbonate content low, and to bring it up, as required, by adding the correct amount of high limestone. A natural ravine in the deposit was shoveled out to a greater depth to afford natural drainage. The face, situated along one side of this ravine, is parallel to the dip of the deposit and in the form of a semicircle. Not for many years will the quarry be worked out to a depth below natural drainage that will necessitate the use of pumps.

The greater part of the drilling is accomplished with a Keystone well drill, operated with a Waukesha gasoline motor and mounted on crawler treads. For faces up to 30 ft. deep, an Ingersoll-Rand drifter drill, mounted on a wagon, is employed. The holes are driven 3 ft. below the floor of the quarry. From 5½ to 6 tons of rock is broken per pound of 40 per cent ammonia dynamite. Loading is done with a Marion 2-yd electric shovel and a 1-yd. Northwest shovel, operated by a gasoline motor. The quarried material is hauled to a crusher in Easton 8-yd., steel, side-dump cars by a Plymouth 14-ton gasoline locomotive, over several hundred feet of standard-gage track. The cars are dumped into hoppers feeding the crusher, the average trainload of six cars totaling 48 tons of rock. Typical analyses of the high-lime limestone, low-lime limestone, and natural cement rock mined at the property are presented in Table I. A supply of rock sufficient to keep the mill operating 24 hours can be delivered in ten hours.

At the crusher house the cars are moved and spotted for dumping with a Link-Belt car haul. A Shepard hoist dumps the contents of the cars into a hopper, from which the stone is fed to a No. 50-50 Dixie hammer mill by a Stephens-Adamson apron feeder. The hammer mill, operating in a pit at the same level as the quarry, has a movable breaker plate that permits it to handle wet and sticky material without clogging. A 250-hp. motor drives the mill, and the breaker plate is adjusted with a 5-hp. motor. The ¾-in. product of the mill falls into a small bin that discharges through a series of hoppers onto a 30-in. Hewitt-Circle belt conveyor, equipped with Link-Belt ball-bearing idlers and inclined, for most of its length, at 16 deg. The conveyor handles about 2,000 tons during a ten-hour shift. It is 480 ft. long and is operated by a 40-hp. motor. From the hammer mill, the conveyor passes through a concrete tunnel and then over a trestle to the raw storage building, where it assumes a level position and discharges at the rate of about 250 tons hourly.

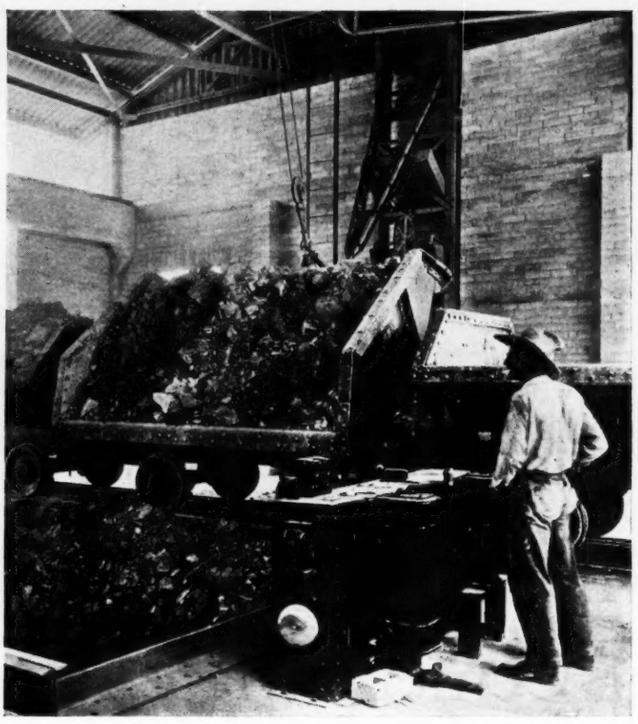
Table I—Typical Analyses of Quarry Products

	High-Lime Limestone, Per Cent	Low-Lime Limestone, Per Cent	Natural Cement Rock, Per Cent
SiO_2	5.68	17.28	14.20
Fe_2O_3	0.46	1.86	1.75
Al_2O_3	2.10	5.48	4.15
$CaCO_3$	89.98	72.81	76.36
$MgCO_3$	1.46	2.37	2.28

The raw storage building is 70 ft. wide by 150 ft. long, and the conveyor delivers both to bins above the raw-grinding mills or into storage. A 150-ft. extension of the building is utilized for the storage of clinker and gypsum. Five of the twelve bins, with a total capacity

of 6,000 tons, are used for rock. Storage space for clinker and gypsum, to the extent of 50,000 bbl. and 350 tons, respectively, is provided by the remaining bins. A Pawling and Harnischfeger overhead heavy-duty crane, of 7½ tons' capacity, equipped with a 3-cu.yd. clamshell bucket, operates the entire length of the building. This crane is driven by two 50-hp. hoist motors, one 50-hp. bridge motor, and a 15-hp. trolley motor.

The mill feed bins, six in all, for rock, clinker, and gypsum, are of concrete, with hopper bottoms, and are situated close to the center of the raw storage building. Through two pairs of 72-in. Allis-Chalmers rotating table feeders that regulate the "mix," these bins feed two Allis-Chalmers Compeb raw-grinding mills. The feed is unique in that each mill receives high-lime rock from one bin and low-lime rock from another. A proper ratio is maintained through adjustment of the flow by changing as needed, the size of the vertical feed opening, the position of the scraper blade, or the speed of rotation of the tables. The gypsum is fed into the mix on the finish-grinding side.



The cars of rock are dumped at the crusher building with the aid of an electrically operated car haul and hoist.

Both of the Allis-Chalmers Compeb mills are 7x8x40 ft., and each is driven by an 800-hp. 180-r.p.m. 2,200-volt super-synchronous motor. Wet grinding is employed. The slurry, which contains 42 per cent water and will pass a 200-mesh sieve, is discharged into a mechanically agitated sump, whence it is pumped into ten cylindrical tanks, 20 and 24 ft. in diameter and 30 ft. high. Six of these, used for blending, empty into a concrete sump, the blend being pumped into the other four tanks, known as correcting tanks. These discharge into another sump, and from here the slurry is pumped into the kiln feeders. Tanks and sumps contain mechanical and air agitators.

The plant is equipped with two unusually large Allis-Chalmers kilns, each 11 ft. in diameter and 250 ft. long, carried on four riding rings, with supports of two-roller type. The kilns are rotated by individual 75-hp. motors, through speed reduction gears, by which the speed of rotation is regulated and the length of the burning period adjusted. Gas fuel is used. The burning period is 43½ hours, and the highest temperature attained is 2,600 deg. F.

All the clinker discharge product of the kilns drops into Allis-Chalmers coolers, 100 ft. long and 10 ft. in diameter, of plate-steel construction, cylindrical in shape, and lined with firebrick for about 30 ft. They are rotated at 1½ r.p.m. by individual 75-hp. motors, and discharge into a pit, from which the clinkers are moved by an overhead crane to the feed bins that serve two pairs of finish dry-grinding mills, opposite the clinker pit. Gypsum bins are also situated close by.

The Allis-Chalmers finish-grinding mills are 7x8x40 ft. Compeb mills, and the feed is regulated through two pairs of Allis-Chalmers table feeders that deliver both clinker and gypsum in the correct proportions. Forged-steel balls are used as grinding media. The mills discharge the finished cement into a screw conveyor that carries it to a pit under the packhouse, where either of two pumps force it through a 5-in. pipe to the tops of storage silos. These comprise two rows of seven silos, each 75 ft. high and 24 ft. in diameter. They are of reinforced concrete construction and set 16 ft. apart. The combined storage afforded is 153,000 bbl.

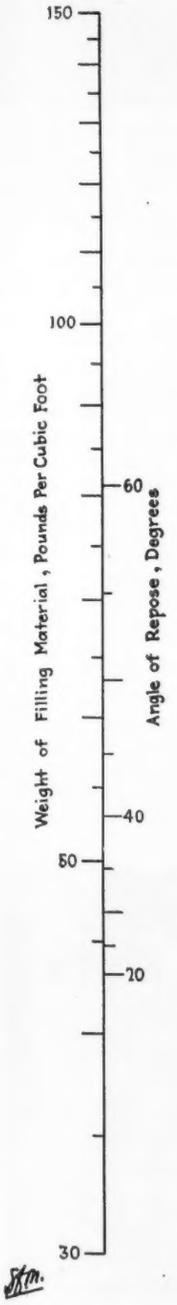
Under the silos are three screw conveyors that take the cement to either of two bucket elevators in the packhouse, which is a four-story structure next to the cement storage. These elevators discharge into two reversible cross-screw conveyors on the third floor, and these, in turn, discharge into feed bins above the bag packers. Spur tracks alongside the cement storage can accommodate fifty cars; and additional car-loading facilities are provided by the two tracks at the packhouse. Conveyor belts take the packed bags direct from the automatic bagging and weighing machines to the cars, and a spout and conveyor are available for delivering bulk cement directly into cars.

Loading cement rock at the quarry with an electric shovel. Drilling equipment, as well as a gasoline-operated shovel, is seen at the extreme left.

BIN-WALL PRESSURE CHART

Designed and Copyrighted by

Sydney C. Mifflen



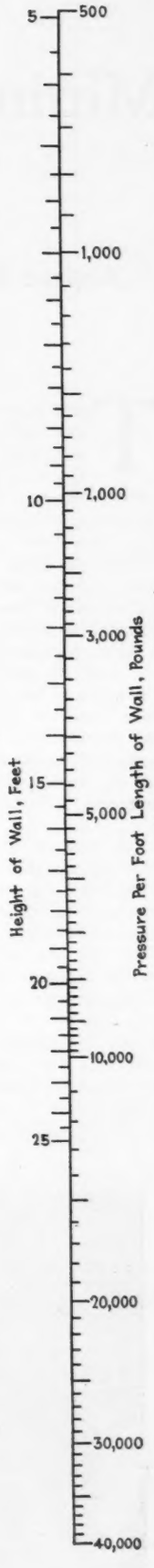
THIS CHART has reference to bins with vertical walls, in which the plane of rupture cuts the free surface of the filling material. It shows the maximum pressure on a bin wall (exerted when the bin is surcharged to the angle of repose of the filling), and is based on Rankine's formula:

$$P = \frac{w\,h^2 \cos\phi}{2}$$

in which w, h, and ϕ represent the weight of filling per cubic foot, the height of the wall, and the angle of repose of the filling, respectively. Rankine assumes the direction of the resultant pressure as being parallel to the top surface of the filling, and the point of application as at one-third the height of the wall.

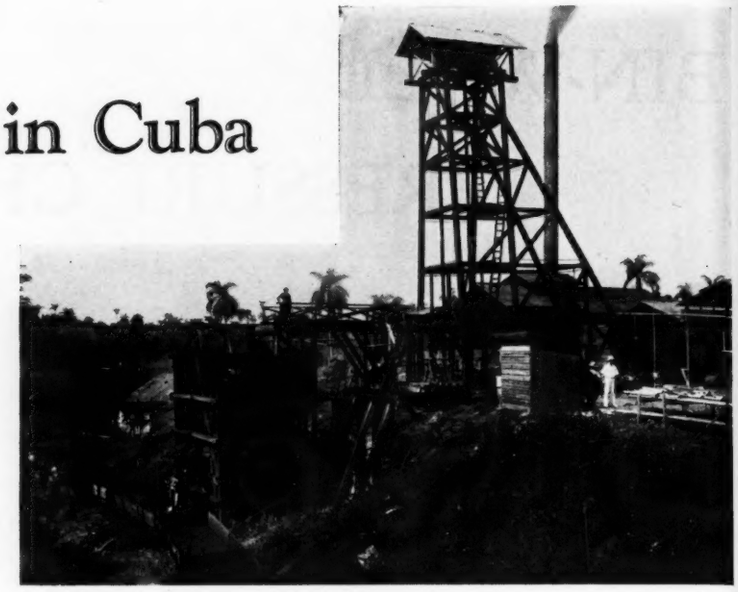
EXAMPLE: What resultant pressure per foot length is exerted on a 12-ft. bin wall when the bin is filled with iron ore weighing 120 lb. per cubic foot? The angle of repose of the ore is 40 deg.

PROCEDURE: Align 12 and 40 on the *Height of Wall* and *Angle of Repose* scales respectively, intersecting the ungraduated scale at a point about which the straightedge is swung to align it and 120 on the *Weight* scale. The intersection on the *Pressure* scale reads 6,600, which is the pressure per lineal foot of wall required.



Mining Asphalt in Cuba

Arthur E. Northey



Surface plant at main shaft and transport equipment used in moving asphalt to shipping docks at Port Mariel

THE first concession for the exploitation of the asphalt deposits near Mariel Bay, on the North Coast of Cuba, about 30 miles west of Havana, was granted by the Spanish government in 1859. Early operations were confined to the mining of small quantities of asphalt from open-cast workings, the asphalt being used as fuel at local sugar mills. Later, the material attracted attention as being possibly suitable for road construction and kindred purposes, and, following satisfactory tests, mining operations were begun in 1900 on a more modern and systematic basis on the Mariel concessions, which comprise 3,705 acres and are owned by the present operating company, Asfaltos de Cuba (Mariel), S. A.

The asphalt occurs in the form of veins of variable width cutting across a complex of sedimentary and serpentinous formations. A series of calcareous rocks comprise the wall formations. These grade from pure limestone to thin bedded shales and sandstones, all containing a large proportion of carbonate of lime. Intercalated with these sedimentary formations are masses of basic igneous rock that have been converted into serpentine. As serpentinization is an expansive process and likely to produce movement and crushing of incasing rocks, evidence of extreme crushing and much movement is a common feature of the wall rocks in the neighborhood of the asphalt veins. These structural conditions account for the veins varying greatly in width, both along the dip and strike, and throwing off tongues of asphalt at any depth or in any direction.

Numerous practically vertical veins or lodes uncovered in the concessions vary in width from two to more than 30 meters. The most important and extensive of these, the Brown vein, has been worked for many years, during which period development work has been continuous. A survey based on development work on the 300-ft. level, the maximum depth of the present workings, shows conservatively a reserve of more than 1,000,000 tons of available mineral in sight in this vein alone. Many other veins opened up for prospecting purposes on the concessions indicate that similar conditions obtain with respect to width and depth of the mineral.

Underground operations follow the methods generally employed in metalliferous lode mining. The asphalt vein, which dips somewhat irregularly to the north, is reached from a vertical shaft. Crosscuts are driven off the shaft at 100-ft. intervals to intersect the vein. A level drive is then driven along the course or strike of the vein. Crosscuts from this main drive, at more or less regular intervals, are driven to prove the width of vein. The main drive on each level is near the hanging wall; but, to avoid timbering costs, the wall is not exposed. Short rises are put up at 50-ft. intervals along the main drive in the asphalt, a stope drift being driven 3 meters above the drive. The rises are continued to the upper workings for stoping and ventilation purposes. Stopes are opened up from the stope drift; arches and pillars are left standing to support the ground. Later

Miners and mine officials, Asfaltos de Cuba (Mariel), S. A., San Juan Bautista, Pinar del Rio, Cuba

on, the pillars and arches will be removed, and the partly filled stopes will be allowed to cave.

Where the vein is wide, rises are put up to the stopes from the crosscuts, and fitted with discharging hoppers, which are used to load the asphalt into tram wagons; otherwise, the rises in the main drive are utilized for that purpose. By loading the wagons from the hoppers in the crosscuts, less interference results with transport along the main drive. The tram wagons are run to the stations at the main shaft, are hoisted to the surface in a single-deck cage, and the asphalt is discharged into storage bins.

All work underground is done by manual labor, including driving in the vein and mining in the stopes. The use of explosives is not advisable. Reasonably skilled miners—and these are generally Spaniards and Portuguese—will each "pick" from 5½ to 6 tons per shift of eight hours. Natural air currents are generally found to be ample for ventilating the underground workings, although, when opening up a new horizon, and until rises are extended to the upper levels, a ventilating fan is employed.

Air is conveyed wherever necessary by means of 8-in. du Pont Ventube, which is light, easily installed, and highly satisfactory in every way. Only occasionally is any inflammable gas, in minute quantities, found in the workings. The asphalt powder will burn, but it is not explosive. Owing to the moist nature of the underground atmosphere, the powder does not float.

The workings are all electrically lighted, current for the purpose being generated on the property. Except during the rainy season, the quantity of water in the workings is relatively small. Pumping is effected by Cameron and Worthington pumps driven by compressed air, supplied from a Bury steam-driven compressor. The main vertical shaft consists of three compartments, two for hoisting and one a ladderway. It is equipped with a heavy-duty triple-drum steam-driven Fleury hoisting winch, with a capacity of 200 tons per day. The steam plant comprises a standard horizontal tubular boiler, crude asphalt from the mine being used for fuel. As such, the asphalt is satisfactory and economical. A small proportion of wood fuel is used in conjunction with the asphalt. Special grate bars are not necessary. From the storage bins the asphalt, as shown in one of the accompanying illustrations, is transported over a railway to company docks at Port Mariel, whence it is shipped in steamers to the United States and Europe.

The mineral is not, strictly speaking, an asphalt, but rather an asphaltite—a mixture of gilsonite and grahamite. It is of a much higher commercial value than asphalt. Although always much in demand, it has not been found in commercial quantities elsewhere. Chemical characteristics, different from those of the asphalts of Trinidad and Bermudez, enable it to be used for the manufacture of an asphaltic cement of an especially rubbery type, less susceptible to temperature changes than cements made from other asphalts.

As mined, the mineral is uniform in composition across the vein. No rare minerals have been revealed as constituents. An analysis of the crude mineral follows:

Total bitumen soluble in carbon disulphide, per cent	51.43
Ash (mineral matter) insoluble in carbon disulphide, per cent	42
Organic matter insoluble in carbon disulphide, per cent	6 to 7
Petrolenes (bitumen soluble in 86 deg. paraffin naphtha), per cent	17.080
Asphaltenes (bitumen insoluble in 86 deg. paraffin naphtha), per cent	34.11
Carbenes (bitumen insoluble in carbon tetrachloride), per cent	1.5 to 2
Bitumen soluble in carbon tetrachloride, per cent	50.105
Fixed carbon, per cent	18.4
Specific gravity	1.492
Moving point	257 deg. F. to 298 deg. F.
Melting point, ball and ring	374 deg. F. to 400 deg. F.
Volatile at 212 deg. F. (water and light oils), per cent	5.170
Flash point, closed	419 deg. F.

A large amount of Mariel asphalt was shipped to the United States before the War, to be used for paving in the larger cities. Subsequently, a gradual increase has taken place in its use for this purpose in Great Britain. The crude asphalt is exported principally to the company's works in England, whence it is distributed in the crude state, or in a pulverized form, or refined and fluxed, in Great Britain, to the Continent of Europe, India, Australia, and New Zealand. Although the major part of this asphalt is consumed in the preparation of penetration and bituminous concrete mixtures for road work, a large amount is also employed in the manufacture of many other articles, such as roofing mastic, weather paint for iron work, damp courses, insulation, floors, acid tanks, gramaphone records, and tarbitumen compounds for road spraying. In the preparation of the tarbitumen compounds, the asphalt, when pulverized and added to the heated tar, with which it readily amalgamates, forms a practically non-skid surface that neither softens and bleeds under high temperatures, nor hardens and cracks in extreme cold.

■ ■

Repair of Diesel-Engine Valve

THE mechanical department of a Mexican mining company was recently confronted with a puzzling problem, the decreased motor performance of a small Diesel engine, the source of power in the crushing plant and the mill. Careful reaming and regrinding of valves were found of no avail. To determine the exact cause for this condition, an indicator was placed on the cylinder head and several diagrams were made. These revealed a considerable back pressure within the cylinder. Removal of the cylinder head led to the discovery that the depressed position of the seat of the exhaust valve—a result of frequent regrinding, as shown in Fig. 1 of the accompanying illustration—retarded the discharge of gas during the exhaust period, allowing much gas to remain in the cylinder. As no spare cylinder head was available, the valve seat was restored to its original position by reboring the valve-seat section and inserting a ring with a press fit, as shown in Fig. 2. This inexpensive method of repair again brought the performance of the motor up to standard.

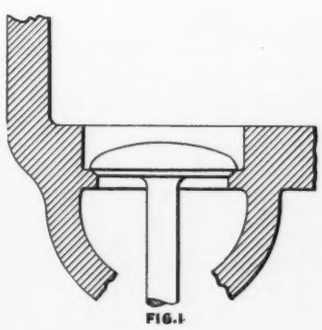


FIG. 1

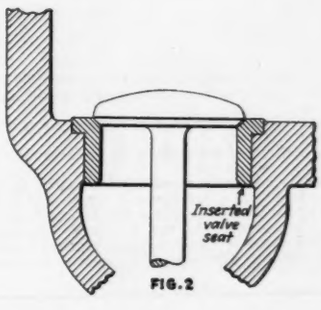


FIG. 2

Copper Production Costs in the Americas in 1930

S. D. Strauss

Assistant Editor

IN 1930, nineteen copper-mining companies produced 1,370,000,000 lb. of copper at a net cost, exclusive of depletion, of 9.73c. per pound. These companies include organizations operating properties in the United States, Canada, Mexico, and Chile. In 1929, nineteen copper-mining companies produced 2,091,000,000 lb. of copper at a net cost, exclusive of depletion, of 9.65c., according to G. W. Tower. These two figures—9.73c. per pound and 9.65c. per pound—are not strictly comparable. In compiling the 1930 average, it was found advisable to omit three companies that have been included in the 1929 list and to include three others for the first time. In addition, certain minor changes were made in the basis of determining costs for some organizations (notably Utah Copper, Copper Range, and Noranda Mines). But, broadly speaking, the figures do indicate that the cost of producing copper did not vary greatly in the two years, despite the violent changes that were effected in the companies' income.

Kennecott Copper, Phelps Dodge, and Cerro de Pasco have been omitted from the 1930 compilation. These three companies, though among the largest copper producers, have other diversified interests—the first two in manufacturing and the third in the mining of other metals. To obtain a figure for the cost of producing copper, one must credit the entire profit of operations to the copper-producing unit and assume that the remainder of the enterprise was run on a cost basis, an obviously untrue assumption. In 1929, these companies' costs were estimated at 7.78c., 12.4c., and 8.01c. a pound, respectively. This is considerably lower than the average costs of Consolidated Coppermines, Greene Cananea, and Walker Mining, the three companies that were added to the list. My calculations indicate costs of 11.07c., 9.05c., and 11.53c. for the latter group. In addition, the new entries produce considerably less copper than do the companies omitted.

Table I—Weighted Average Costs of American Copper Production

All figures in cents per pound of copper

	1929(a)	1930(b)
Operating	9.92	9.51
Taxes, interest	1.21	0.84
Depreciation	1.07	1.05
Miscellaneous expense	0.13	0.01
Total	12.34	11.41
Sundry metals	1.52	1.20
Miscellaneous income	1.17	0.48
Net costs, after depreciation	9.65	9.73
Copper output, millions of pounds	2,091	1,370

(a) Includes Phelps Dodge, Kennecott, and Cerro de Pasco, not in 1930 list.
(b) Includes Consolidated Coppermines, Greene Cananea, and Walker Mining, not in 1929 list.

The first table, showing weighted average costs for the entire group in 1929 and 1930, presents an interesting commentary on the vicissitudes of a year of depression. Operating expenses were cut from 9.9c. a pound to 9.5c. Taxes and interest dropped from 1.2c. to 0.84c., attributable in part to the lowered taxes on net income and in part to the fact that neither Utah nor Nevada Consolidated, large producers both, made any provision for this item in their 1930 accounts. Depreciation charges were off slightly. Probably this reflects the fact that the omitted companies have heavier capital investments, proportionally, than the ones that have been added. As a whole, and before deducting credits, the 1930 charges were nearly 0.9c. per pound lower than in 1929 (11.4c., compared with 12.3c.).

Lower prices for silver, an important byproduct at most of these mines, and the omission of three companies that produce large quantities of other metals, are probably responsible for the drop in sundry-metal income. Decreased dividends from investments in other companies helped to cut miscellaneous income by more than 50 per cent. In this respect, mention should also be made of the fact that Mr. Tower's compilation included a large credit to Utah Copper's income which resulted from Nevada Consolidated dividends. Because of the size of this income, which

Table II—Production Costs in 1930 of Leading Copper Companies

All figures in cents per pound of copper produced

Company	Production, Millions of Pounds 1930	Operating Costs	Taxes and Interest	Miscellaneous Expense	Depreciation	Depletion	Sundry Metal Income	Miscellaneous Income	Costs After Depreciation Before Depletion	Costs After Depreciation and Depletion
Andes	128.7(a)	7.83	0.86(b)	.....	1.01	.....	0.20(c)	0.17	9.33	.....
Calumet & Arizona	88.8	10.45	1.54	0.45	1.00	.....	1.77	0.43	11.24	.....
Calumet & Hecla	105.7	8.62	1.30(d)	0.17	0.89	1.06	.....	0.26	10.72	11.78
Chile Copper	219.5(a)	5.38	1.84(b)	.....	1.15	.....	.....	0.38	7.99	.....
Con. Coppermines	32.6	11.53(e)	0.08(f)	.....	0.40	.....	0.89	0.05	11.07	.....
Copper Range	23.8	11.83(g)	0.47(h)	2.73(i)	.....	.....	.....	3.99(k)	11.04(l)	.....
Granby Con	46.8	12.59	0.56(j)	.....	2.88	1.29	0.69	0.50	14.84	16.13
Greene Cananea	51.5(a)	9.11	0.36(b)	.....	0.62	.....	0.53(c)	0.51	9.05	.....
Howe Sound	45.27	23.07	0.65	.....	1.96	.....	16.53	0.99	8.16	.....
Inspiration	65.6	8.94	0.97(f)	.....	0.49	.....	.....	0.04	10.36	.....
Magma	31.9	7.94	1.13	0.39(l)	1.40	.....	1.79	0.31	8.76	.....
Miami	62.1	10.24	0.64	.....	0.81	.....	.....	0.22	11.47	.....
Mohawk	13.3(m)	8.28(m)	0.44	.....	0.67	0.32	.....	0.88	8.51	8.83
Mother Lode	9.65	11.16	0.69	.....	.....	5.17	0.29	0.04	11.52(t)	16.69
Nevada	141.98	10.97(n)	.....	.....	1.27	.....	0.46	0.93	10.85	.....
Noranda	75.0	8.38	0.64	.....	1.80	0.60(o)	3.41	0.60	6.81	7.41
United Verde Ex	45.6	8.49	1.37(p)	.....	0.02	6.27	0.97	0.67	8.24	14.51
Utah Copper	161.1	8.80(n)	.....	.....	0.89	.....	0.92	0.30(q)	8.47(q)	.....
Walker	15.8(a)	13.85(r)	0.10(s)	.....	0.53	.....	3.12	0.18	11.53	.....

(a) Based on sales of ore, concentrate, blister, or refined copper in 1930, not on actual production. This applies to the entire set of statistics for these companies.
(b) Includes taxes and miscellaneous charges as well as interest and bond discount, if any.
(c) Estimated proportion of precious-metal content of copper sold. Silver taken at 38c. an ounce.
(d) Includes selling and administration charges as well as taxes.
(e) Including a development charge that is omitted in official cost statements.
(f) Miscellaneous charges and federal income tax only.
(g) Includes freight, tax, selling, and general expense.
(h) Interest on Copper Range railroad bonds only.
(i) Includes railroad and miscellaneous expense.
(j) Includes insurance, taxes, and administrative expenses.
(k) Includes railroad and miscellaneous income.
(l) Includes administrative expenses and loss, after depreciation, on railroad operation.
(m) Partly estimated, due to storage of concentrate.
(n) Includes local taxes. No provision made in 1930 for federal income tax.
(o) Prior development and mining.
(p) Includes other expenses.
(q) Does not include dividends received, largely from Nevada. They would furnish a further credit of about 2c. a pound.
(r) Partly estimated, as concentrate is sold to custom smelter.
(s) Federal income tax only.
(t) Does not include depreciation.

cannot fairly be called part of the cost of producing copper, I have omitted it and used, as a basis for calculating the company's miscellaneous income, only those credits that accrue from the Utah operations.

On the whole, there can be no doubt that, had precisely the same basis been used and the same companies included in the 1930 compilation as in the 1929, the cost of producing copper would have shown a drop of about 0.2 or 0.3c. a pound. For 1931, a reduction much more sizable than this is probable, particularly if the market situation improves sufficiently to permit a slight increase in the operating rates at mines still in production. The penalty of operating at 35 to 40 per cent of normal capacity is a heavy one, and, in highly mechanized operations, such as Calumet & Arizona or Utah Copper, it may well counterbalance any advantage gained through handling higher-grade ores, a lower wage scale, and lessened cost of supplies.

The increasing complexity of the art of accounting, the increasing diversity of the interests of copper companies, and the increasing tendency of some companies to omit detailed figures make almost impossible any accurate comparison between companies. Only the three Anaconda-controlled organizations (Chile, Andes, and Greene Cananea) and the two Kennecott satellites (Utah and Nevada) can be said to furnish figures that can be compared with each other. It has been necessary in these tables to take certain liberties. Some of the results arrived at vary considerably from the official company statements. However, all such cases have been duly footnoted; the reader is asked to take cognizance of them.

The companies that made the most notable reductions in cost included Calumet & Hecla, Copper Range, Howe Sound, Inspiration, Magma, and Noranda. The first two operate in the Michigan copper district. Wages play a larger part in their costs, probably, than in the costs of other producers. The reduction in the wage scale, plus a more careful selection of ore and the closing of high-cost units (notably Copper Range's Trimountain shaft), account for the reduction in costs. Despite low prices for lead and zinc, Howe Sound increased production of its metals other than copper and improved practice sufficiently to account for the better cost record of 1930. Noranda's drop of more than 2c. per pound was engineered by a greater production of gold and silver and by the economies that can be introduced in handling greater tonnages.

Table III—Per Pound Costs for Individual Companies in 1929 and 1930 (a)

All figures in cents per pound of copper

	1929	1930
Andes	9.44	9.33
Calumet & Arizona	9.84	11.24
Calumet & Hecla	11.46	10.72
Chile Copper	8.01	7.99
Consolidated Coppermines	(b)	11.07
Copper Range	14.46(c)	11.04(c)
Granby Consolidated	14.11	14.84
Greene Cananea	(b)	9.05
Howe Sound	9.69	8.16
Inspiration	11.46	10.36
Magma	10.29	8.76
Miami	11.98	11.47
Mohawk	7.09	8.51
Mother Lode	6.80(c)	11.52(c)
Nevada	10.16	10.82(d)
Noranda	9.96(e)	7.41(e)
United Verde Ex	8.42	8.24
Utah Copper	7.47(f)	8.47(f)
Walker Mining	(b)	11.53

(a) Includes depreciation and all charges except depletion.
(b) Not compiled in 1929.
(c) Does not include depreciation.
(d) Does not include federal income tax in 1930. In 1929, this was a charge of 0.57c. per pound.
(e) Includes a charge for prior development.
(f) The 1929 figure includes a charge of 0.81c. a pound for federal income tax and a credit of only 1.10c. per pound for miscellaneous income. The 1930 figure includes no income-tax charge and a credit of only 0.30c. per pound for miscellaneous income. As stated in the article, income from Nevada Consolidated dividends has been omitted.

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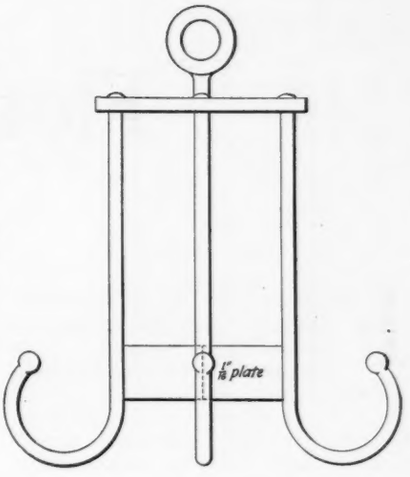
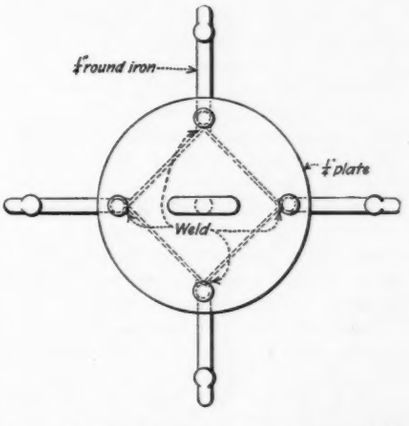
Clothes Hanger for Change Room

FROM a safety standpoint, the use of wooden clothes hangers in change rooms is unsatisfactory. Generally made of green wood, the boards dry up too quickly in the warm temperature of the rooms, crack, and may break and thereby injure the operator while he is lowering his clothes. To avoid such an occurrence, all change rooms at the Navada Consolidated Copper Company's mine at Ray, Ariz., have been equipped with all-iron clothes hangers, as illustrated in the accompanying sketch. The device weighs but 1½ lb., as compared with 7 lb., the weight of the wooden holder formerly used, and is made of ½-in. round iron and ¼- and ⅛-in. plate, as indicated.





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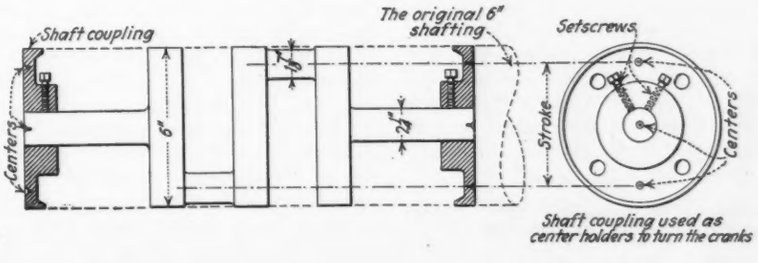
Small Crankshaft From Scrap Shafting

UNABLE to weld a small broken compressor crankshaft or to forge a new one, lacking suitable welding material and adequate repair facilities, the problem was solved satisfactorily by the lathe man, writes Charles Labbe, of Death Valley, Calif. A piece of 6-in. scrap steel shafting was cut to length, centered, and turned down at the ends to fit the bore of two shaft couplings tightly, as shown in the accompanying sketch. The crank centers were then marked and drilled on the flanges attached securely to the shaft by the provided setscrews, and the cranks and 6x2-in. disks turned down after the face plate had been first balanced out with the bolted-on counterweights. Finally, the flanges were removed from the shaft, and the shaft ends turned according to the size of the bearings and the flywheel bore.



Flotation Reagents

A. M. Gaudin

FLOTATION, as known today, would be impossible without reagents, most of which are employed to affect floatability, increasing that of some minerals, decreasing that of others. Other **reagents,** however, are added to insure the formation of a dispersion in the pulp of minute air bubbles, which cream into a froth. Such *frothers,* as they are termed, are liquid organic substances, generally of sufficiently high viscosity to be termed oils. Their solubility in water is slight, compared with that of many substances, but dissolution of the reagent is necessary. Such solubility cannot, therefore, fall below a rather definite limit of 1 in 10,000 to 1 in 100,000.

Dissolved frothers are generally not ionized. Their molecules are composed of two parts, one of which is polar, like water, and the other non-polar, like paraffin, oxygen, or nitrogen. The frother molecules arrange themselves at the boundary between air bubbles and water with their polar (water-soluble) part in the water and their non-polar (water-insoluble) part in the air. Thus they stabilize the gas in water dispersion necessary for flotation. Pine oil, cresylic acid, and eucalyptus oil are the most widely used frothing agents.

Reagents that promote or increase the floatability of minerals are of three types, as follows:

1. *Collecting Oils*—Collecting oils are substantially water-insoluble, viscous, emulsifiable, organic liquids which adhere to the surface of certain minerals as minute droplets of non-polar character. Chemically, these oils are mixtures of many substances, some of which are altogether non-polar, and others polar in one part of the molecules and non-polar in the other. They are typified by coal-tar creosotes and coal tars of medium to high boiling range. Collecting oils, a remnant of former flotation days, are retained in some plants for their froth-toughening qualities.

2. *Chemical Collectors* — Collecting oils are being replaced by chemical collectors which effect better collection of the minerals wanted in the froth, at a lesser cost and with more complete exclusion of the minerals not wanted. Chemical collectors are organic salts or weak organic acids, capable of forming insoluble salts with the metals of the minerals to be collected. They are therefore polar in one part of the molecule and non-polar in another part; furthermore, the polar portion is ionizable into one wholly polar cation and a partly polar anion, which is the active constituent.

Soap, xanthates, dithiophosphates (Aërofloat), mercaptans, and thiocarbanilide are the principal chemical collectors. All of these agents have to be used with great care, as a small excess may result in a dirty concentrate, and a small deficiency may effect a poor recovery. Soaps (and fatty acids) are the most general, and therefore least selective, collectors; their use is restricted to the flotation of minerals for which no specific collectors have been discovered. In practice their application is limited entirely to the flotation of non-metallic and oxidized base-metal minerals. Xanthates and mercaptans combine great effectiveness with specificity to the minerals of lead, copper, silver, mercury, and iron. A search for more and more specific collectors is actively conducted.

Of collectors, amyl xanthate is the most effective in the flotation of sulphide and oxidized copper and lead-zinc ores. Its specificity to copper, lead, or copper-sulphide-plated zinc minerals is not lessened by its greater effectiveness.

3. *Activators* — Activators are inorganic salts, which by reaction with otherwise non-collectible minerals permit collection of these minerals by oils or chemicals. The best known is copper sulphate, universally employed to float sphalerite.

Some reagents are used to decrease the floatability of certain minerals without affecting that of others. Their use in conjunction with promoters and frothers magnifies the selection between different mineral species. Inhibitors are both organic compounds of the protective-colloid type such as glue, gelatin, and casein, and inorganic salts. Inorganic salts form the great majority of inhibiting agents. These salts contain ions capable of wetting (or hydrating) the mineral surface, as, for example, the hydroxyl ion, OH^-, of alkalies; ions capable of forming ionic complexes, as the cyanide ion, CN^- (which may form $Cu(CN)_3^{--}$); oxidizing ions as $Cr_2O_7^{--}$; and ions forming insoluble precipitates with minerals, as CrO_4^{--}. The most important inhibitors are lime, zinc sulphate, sodium sulphide, sodium sulphate and sulphur dioxide, dichromates, cyanides, and sodium silicates.

Pyrite and pyrrhotite are inhibited by lime, dichromates, and cyanides; activated sphalerite is inhibited by cyanides, sodium sulphite, sulphur dioxide, and zinc sulphate; galena by chromates; chalcopyrite by cyanides; and fine silicates by alkali silicates.

A scale for regulation of acidity or alkalinity (pH determinations) similar in some respects to the Fahrenheit temperature scale has been designed. Such regulation is essential to successful flotation, as variations in pH change the effectiveness of promoting and inhibiting agents, as well as the frothing obtained with equal amounts of frothing agents.

As most circuits are more alkaline than the natural ore pulps, alkaline pH regulators such as lime, soda ash (sodium carbonate), sodium hydroxide, sodium sulphite, sodium silicate, ammonia, and sodium sulphide have been used. For acidification, sulphuric acid is widely used.

Reagent Feeding

Satisfactory flotation results cannot be obtained without complete control of reagent feeding. This control implies three different requirements of the feeder: (a) Maintenance of uniform feeding rate if no change is made in the adjustment of the feeder; (b) easy, rapid adjustment of the rate of feed; (c) possibility of fine adjustment.

The first condition excludes intermittent feeding except where the frequency of feeding is sufficiently high to provide substantially constant conditions in the pulp a short time after the addition. The first condition, furthermore, demands a mode of feeding independent of those properties of the reagent which may be affected from time to time. For instance, feeders depending on the viscosity of an oil (which is a function of temperature) cannot be expected to be as accurate as feeders depending on the speed of a motor-driven belt or chain.

The second condition demands a sturdy, strong, yet accessible piece of machinery with a suitable calibration chart that is easily calibrated when adjusted. The third condition requires at least one of the adjustments to be of a continuous nature.

Abstracted from Bulletin 2902, Denver Equipment Company, Denver, Colo.

Reagents may be fed in the liquid or solid state. Solid reagent feeding is not as desirable as liquid feeding, as time is required for the solid to disperse and dissolve. For slightly water-soluble substances, solid feeding is still the simplest way of introducing the reagent, as it does not involve the bulky equipment required to make up the solution prior to addition to the pulp.

Liquid reagent feeding is used exclusively for introducing oils, and also increasingly for the introduction of highly soluble salts, as it produces the effect of the reagent on the pulp more quickly. Liquid feeding of salts involves the provision of dissolving tanks, frequently in duplicate, to permit the preparation of the solution in batches without interruption in feeding.

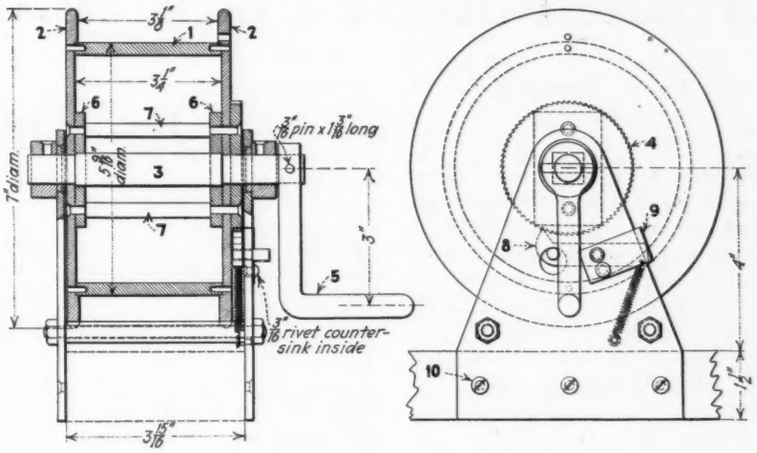
In common practice reagents are added as follows: (1) Frothers in the liquid state; (2) collecting oils in the liquid state; (3) xanthates in aqueous solution, thio carbanilide in solid form or dissolved in a frothing oil, dithiophosphates in aqueous solution or dissolved in cresylic acid, soaps in aqueous solution, fatty acids in the solid or liquid state; (4) copper sulphate in solution or in the solid state (preferably the latter); (5) lime in the solid state or as a slurry; (6) inorganic salts in the solid state or in solution.

To obtain the best operating results, the reagents should be added at different points: some should be fed to the grinding mill or classifier overflow, others at various points in the flotation circuits, and still others in special conditioning tanks. Flexibility in this respect is a desirable feature of reagent-feeding installations, as it permits changes in practice for experimental purposes as well as more delicate adjustment following changes in the character of the ore.

■ ■

Easily Made Reel Simplifies Shaft Plumbing

TO PLUMB shafts with provisional set-ups or unsuitable instruments causes waste of time and gives inaccurate results. A practical plumbing reel is required to simplify and to speed up this work. A reel designed by C. S. Watt, of Auburn, Ind., shown in detail in the accompanying illustration, embodies many novel and interesting features, and it may be made at the mine machine shop from scrap material. Reel drum (1), made of 5-in. steel pipe, rests between the recessed steel flanges (2) to prevent the plumbing wire from getting stuck between the flange and the drum. Additional parts required are a spindle (3), made of a short ¾-in. square bar, turned down at the ends to ⅝-in. diameter; the mild-steel ratchet wheel (4), 3.024 in. in diameter and ¼ in. thick, fitted with 76 teeth, cut at an angle of 63 deg.; a handle (5); two turning bars (6), secured to the drum flanges and ratchet wheel by the two rivet pins (7); and two light bracket plates, to one of which is attached the ratchet pawl (8) and the pawl-release spring (9). The complete unit is screwed on a wooden board, shown at the bottom (10).



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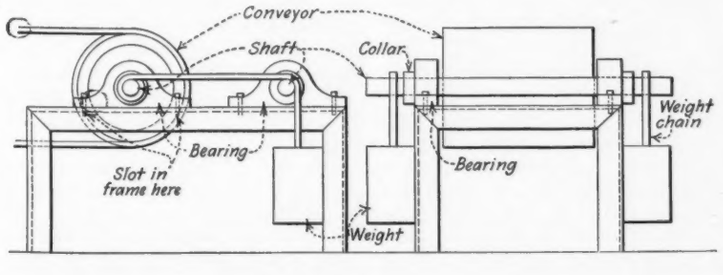
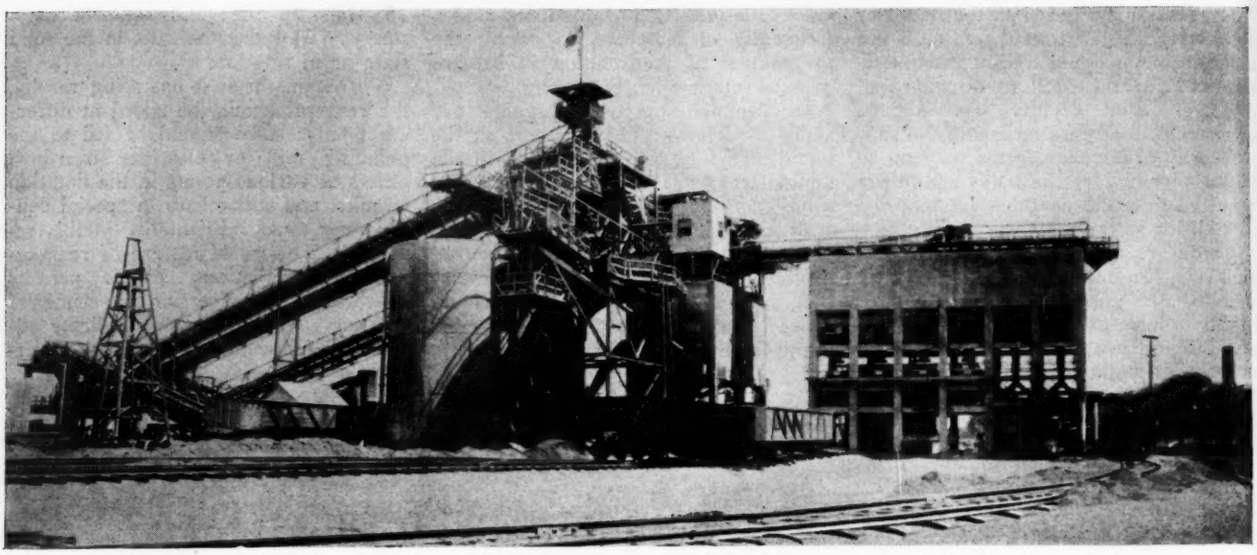
Automatic Conveyor Tightener Prevents Slippage

AN UNDESIRABLE occurrence in the operation of a chain conveyor is the slippage of links caused by chain slackness, as it incurs rapid wear of the chain, sprocket wheels, and drive mechanism, writes R. M. Thomas, of Denver, Colo. Such occurrences are especially frequent with conveyors exposed to the heat from a furnace or a kiln; repeated adjustments are necessary to counteract expansion and contraction, causing expense and loss of operating time. This can be effectively overcome by the use of the self-adjusting, simple tightener shown in the accompanying illustration. It consists of two counterweights, two short chains, and a stationary shaft, supported and held in place by two bearings and two collars fitted with setscrews, on the drive end of the conveyor. The four slots on the end base of the conveyor, with the loosely adjusted bearing bolts, secured by counter nuts, render the entire conveyor end movable, thus permitting the counterweights to balance and to hold the conveyor chain under constant tension. On heavy conveyors the weights should be suspended from longer chains into depressions cut in the floor.





The receiving end of the gravel plant is on the left, the open deck construction over the "silos" supporting the screening equipment. On the right is the discharging end.

Crushed-Stone Plant Adopts Ore-Dressing Practice

G. J. Young
Associate Editor

The preparation of crushed stone for utilization in concrete and road work is an important industry. Likewise, the gravel and sand industries are indispensable. In 1929 production in tons was as follows: crushed stone, 92,721,000; gravel, 107,090,000; building sand, 42,000,000; other sand, 42,000,000; molding sand, 6,000,000; and glass sand, 2,200,000. The total of 292,011,000 tons is impressive. The value of these products exceeds $200,000,000, and the total number of companies in the crushed-stone business was 1,453 in 1929 and the number of sand and gravel pits about 2,400.

Quarrying, transportation, and preparation of this material requires mechanical plants of varying kinds, but all involve rock crushing, screening, and grading, for crushed stone, and, for gravel, screening, washing, and grading, and sometimes crushing. Crushed-stone operations necessitate drilling, blasting, loading, and transportation; whereas gravel deposits need only excavation, drainage, loading, and transportation. That the exploitation of a gravel deposit involves lower costs and less elaborate equipment is evident and the final costs are usually lower than for the crushed-rock products.

OF MORE than ordinary interest is the gravel plant recently completed one mile east of Pleasanton, Calif., by the Kaiser Paving Company, of Oakland. In its design, Thomas M. Price has drawn on a large amount of experience and incorporated many devices developed in ore-dressing practice. It is constructed of reinforced concrete and steel and includes modern crushing, screening, and washing appliances.

The pit site is level, with gravel covered by a soil and sandy clay layer of varying thickness. The gravel is uniform, with some plus-4-in. oversize and 40 per cent minus-¼-in. mesh. Similar deposits in the vicinity have been worked for a number of years. A P. & H. 3-cu.yd. full-revolving caterpillar-mounted electric shovel is used for excavation and loading. Two parallel tracks serve the shovel and on each is operated a 20-yd. Western air-dump car drawn by a 12-ton Plymouth locomotive equipped with an Atlas-Imperial diesel engine.

The cars dump into a hopper the top of which is 25 ft. below original ground level. Two Bodinson 24-in. reciprocating feeders, *vis-a-vis*, serve an inclined conveyor which discharges upon a Symons manganese-bar, grizzly-type vibrating screen, with 4-in. openings. Oversize goes to an 18x36-in. Allis-Chalmers jaw crusher and undersize and crusher product go to two 30-in. belt conveyors in series, which deliver to the top of the screening and washing plant.

Two 4x10-ft. double-deck Robins Gyrex screens receive the gravel flow plus water and deliver three products, an oversize plus 2½ minus 4 in., an intermediate size minus 2½ in. plus ⅞ in., and a minus-⅞-in. undersize. The oversize is delivered to a bin and thence by a plate feeder to a 4-ft. Symons cone crusher (100-hp. slip-ring motor direct connected), which discharges upon the conveyor delivering to the gravel system or to a 24-in. conveyor by which it is elevated to the crushed gravel division, where it is received by a double-deck Symons rocker-arm vibrating screen, which removes oversize and delivers an in-between product, plus 1¼-in., to crushed-rock bin No. 1. The minus-1¼-in. product is passed over a 4x8-ft. single-deck Niagara screen, with ¼-in. openings. Undersize and water are laundered to an 8-ft. Dorr classifier and the plus ¼ minus 1¼ is conveyed to two 4x8-ft. Niagara screens in series, which produce three sizes. The bins discharge upon a 30-in. perforated loading belt, on which the product is washed and then delivered to cars for shipping or for the stockpile.

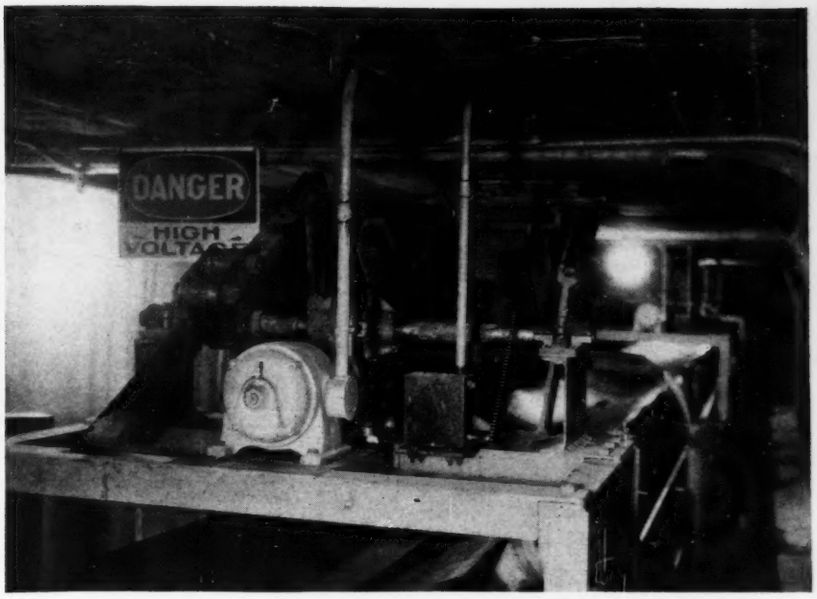
The intermediate product, minus 2½ plus ⅞ in., is discharged upon a single-deck vibrating screen with 1¼-in. holes, the oversize going to a similar screen from which undersize and oversize are delivered to No. 1 and No. 2 silos

respectively. Undersize from the first screen (minus 1¼ in.) is received upon two double-deck vibrating screens (½-in. and ¼-in. holes), the oversize and intermediate products being received in No. 3 silo and the undersize and water being laundered to an 8-ft. Dorr classifier.

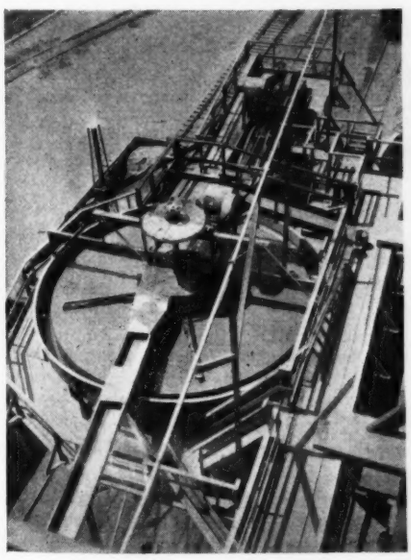
The minus-⅞-in. undersize, containing also sand, silt, and water, is divided between two single-deck vibrating screens with ¼-in. holes, the oversize going to two single-deck vibrating screens with ½-in. holes. These separate an oversize, which is delivered to No. 6 silo, and an undersize, which is received upon two double-deck vibrating screens with ¾-in. and ¼-in. holes. The plus ¾ goes to No. 4 silo, the minus ¾ plus ½-in. to No. 5 silo and the ¼-in. plus water, which is laundered, to the 6-ft. Dorr classifier. The minus ¼-in., gravel, sand, silt, and water, are delivered to a Dorrco sand washer, which delivers sand to the 6-ft. and 8-ft. Dorr classifiers, where it is dewatered and is discharged into the sand bins. Overflow from the sand washer and classifiers is laundered to a 20-ft. bowl classifier, the overflow of which is run to a waste pond. Sand from the bowl classifier is pumped by a 2-in. Wilfley pump to a divider, which apportions it between the 6-ft. and 8-ft. Dorr classifiers, each in turn discharging dewatered sand into the bins. The removal of clay from the sand is efficient. Drag classifier water overflows are returned by a Wilfley pump to the initial scalping screens at the top of the gravel plant, where the water is used for the first washing.

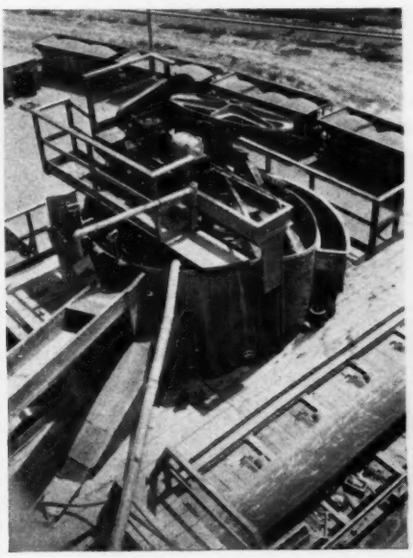
Three sets of bins are in use—six silos, two sand and six surge bins. The silos are reinforced concrete, circular bins, 24 ft. in diameter by 60 ft. deep, 40 ft. being above ground level and 20 ft. below. On the side of each a gate and chute permit loading directly into railroad cars, and at the ground line are ports and aprons so that material can be delivered into the empty bin from the storage piles, as no gravel is shipped direct from storage. The bottoms of the circular storage bins are served by remote-control gates and spouts delivering to conveyors beneath, and these deliver to three conveyors in series for distribution in the surge bins by a Bodinson tripper. "Rockladders" are being provided for the circular bins, so that the gravel falling into them is slowed down and breakage is reduced to a minimum. The "ladders" are equipped with shelves which reduce the free fall to a short vertical distance. A series of holes in the side of the tower discharge in sequence as the bin fills up.

The sand bins are beneath the classifiers and discharge directly into railroad cars. The six small surge bins are elevated in a reinforced-concrete structure apart from the main plant. Each size is delivered to its appropriate bin. Four of the bins discharge through rack-and-pinon gates and spouts to individual single-deck Gyrex screens, each screen being of the limiting size. Undersize and final wash water are thus eliminated by the screen and fall into a hopper beneath, the undersize being automatically returned to the plant feed. Correctly sized material is delivered to a 48-in. perforated conveyor belt and discharged over a mechanical mixer into the cars. The surge bin unit, with its six bins, enables a blended product or any one size, free from breakage and erosion fines, to be delivered to the cars. The perforated belt allows the wash water to drain away to the hopper beneath. Undersize from the hopper beneath the surge bins is dewatered and



Remote-control hopper gates beneath silos—note belt conveyor beneath the spout





At the left is the bowl classifier used for the final separation of fine silt and clay from the fine sand; in the middle is the sand washer; and on the right the 4-ft. cone crusher used for crushing oversize gravel

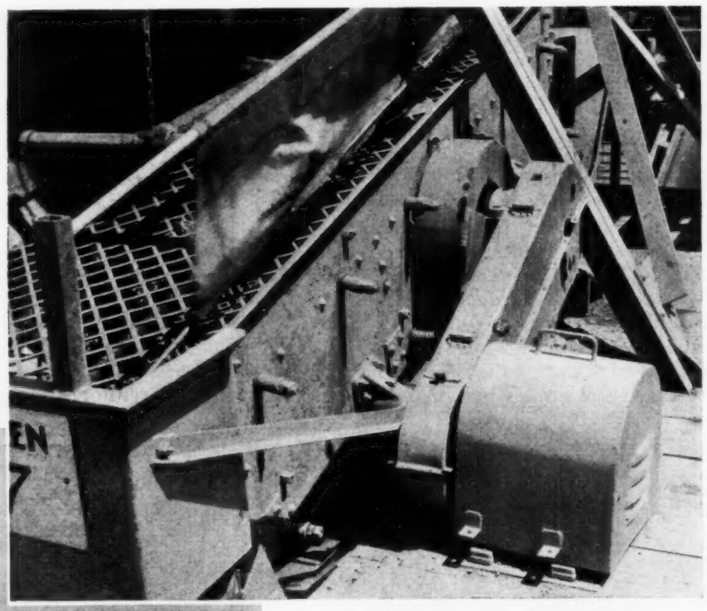
At the left is a general view of the pit showing one of the trains en route to the dumping bin; above is the electric shovel and one of the locomotives used in the pit.

returned by conveyor to the gravel plant. A sump is placed at the low point beneath the silos and is served by an automatically controlled pump. A similar sump pump drains the primary feeder space beneath the receiving hopper.

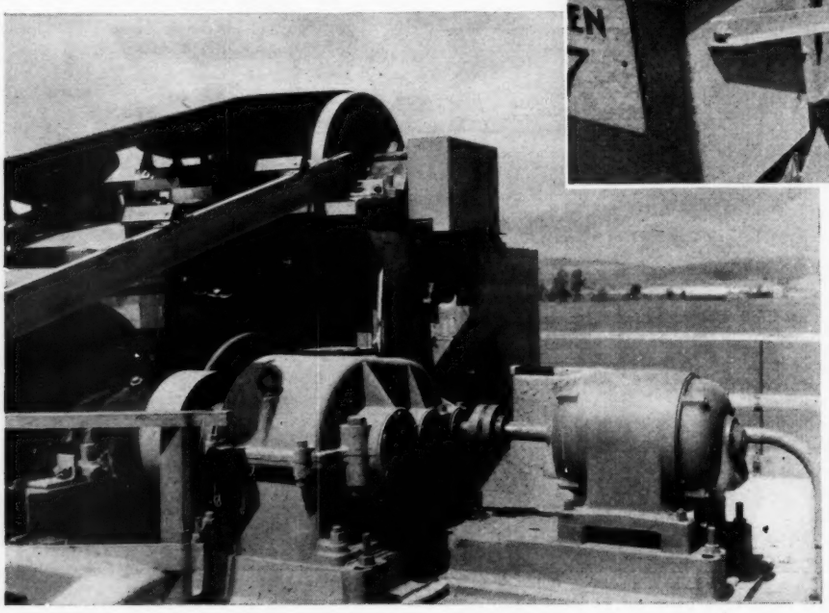
Conveyors are equipped with tandem drives operated by speed reducers and inclosed Sterling motors. Two control stations are features of the plant. One has to do with the incoming gravel stream and the other with the outgoing products, the former being placed at the extreme top of the plant and the other above the surge bins. At both stations are push-button controls and an operator. Each "chain" of conveyors is arranged so that in the event of a motor stoppage, the motors ahead of it in the flow are stopped while the remainder continue to function. This arrangement avoids spills and cleanups.

Screens are 4x10 ft. and 4x8 ft., single and double, of the Gyrex and Niagara types. They are operated by Texrope drives and U. S. inclosed motors. Fairbanks-Morse inclosed motors are used on the Niagara screens. Classifiers are of the duplex Dorr Type F and bowl types. Pumps are of the Wilfley type. Water is supplied from an 18-in. well, 500 ft. deep, by a 2,000-g.p.m. Bradford deep-well pump operated by a 200-hp. U. S. motor. A Brownhoist locomotive crane equipped with an Atlas Imperial diesel engine is used for stock-piling and a 50-ton Plymouth gas locomotive for yard switching. A small machine shop with welding equipment is available for repair work.

The electrical installation was designed by L. F. Leurey. Power leads and wiring are in conduit. Voltage is 440. The spray and water incident to washing the gravel and the open nature of the plant required motors and other electrical equipment to be protected, this being a feature of the plant.



Above, one of the vibrating screens, showing motor and inclosed drive—note welding of parts



A conveyor drive, showing inclosed motor and speed reducer

New Publications

WORLD MINERALS AND WORLD POLITICS. *By C. K. Leith. New York: Whittlesey House, McGraw-Hill Book Company; $2. London: McGraw-Hill Book Company, Ltd. 10s.*

Dr. Leith restates in this volume his well-known views on the relationship between mineral resources and international politics. He cites the problems arising from the facts that modern civilization, which is based on minerals, must have them on a scale of supply previously unknown; that war, offensive or defensive, cannot be fought successfully without adequate mineral supplies; and that, unfortunately, nature has not bestowed mineral resources on all nations with equal generosity. The nations are interdependent in regard to mineral supplies. Dawning public recognition of the situation is leading each nation to look abroad for its requirements, to exploit foreign sources with increasing intensity, wherever it can; to guard its own resources more jealously, and to attempt to regulate its own mineral industries more closely, to prevent waste. In the future, this problem of regulation is likely to become more acute as commercial integration of the mineral industries proceeds. Conservational results thus far obtained by private interests seem to Dr. Leith, however, to warrant continuation of the method of private control, which is already deeply rooted, "with the idea of introducing government control only as a supplement and aid in phases of the undertaking which time may prove to be beyond the power of private effort." The open-door policy in regard to minerals, he says, needs clarification and qualification before it can become established as an equitable basis for international dealing. It must be coordinated with policies relating to conservation, tariffs, and taxes. Mineral import tariffs, he thinks, will come in for extensive review and adjustment to world conditions, as determined by highly unequal geographic distribution of mineral supplies. Order must be introduced into the chaos of mineral taxation.

To study these and kindred problems the A.I.M.E. initiated a so-called "Mineral Inquiry," of the central committee of which Dr. Leith is chairman. The new book is intended as an opening statement of some of the problems. though it does not necessarily reflect the individual views (says Dr. Leith) of the committee's members, including, besides the chairman, H. Foster Bain, G. Temple Bridgman, M. L. Requa, and J. E. Spurr. A. H. HUBBELL.

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THE MINES HANDBOOK. *Vol. XVIII. By Lenox H. Rand and Edward B. Sturgis. In two parts. Pp. 2936. Suffern, N. Y.: Mines Information Bureau; $25 per set.*

AFTER an interval of more than four years—during which the industry was forced to use less accurate and comprehensive works—a new edition appears of The Mines Handbook, covering all the important and most of the unimportant mining companies operating in the two American continents. To any one who has frequent occasion to need such a work of reference, its appearance is a cause for relief and rejoicing. Nowhere else can one be so certain of obtaining information on obscure metal mines not listed in the usual financial handbooks. Nowhere else can the record of the large mining companies be found so compactly summarized.

The current edition appears to be as good as were its predecessors. One disconcerting feature is that, because of of the time that elapsed between its preparation and publication, the main body of the book contains data on operations up to the end of 1929 only. In the appendix can be found some of the more important results obtained in 1930, though it is not, of course, as complete as the main section. Typographical errors are infrequent, and the accuracy of the work as a whole cannot be questioned. The new method of publishing —with all the United States mines in one volume and the mines outside the United States is another—is convenient. In appearance and binding the book is similar to earlier editions.

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FIELD GEOLOGY. *F. H. Lahee. Third Edition. New York: McGraw-Hill Book Company; $5. London. McGraw-Hill Book Company, Ltd. £1 5s.*

This book has been expanded in a new edition to take recognition of and cover various methods of scientific research in structural geology that have undergone great development in recent years, such as geophysical prospecting, micropalaeontology, chemical analysis of subsurface waters for structural interpretation, measurement and interpretation of geothermal gradients in relation to geologic structure, surveying of deep boreholes for correct interpretation of subsurface structure, and airplane mapping of geologic terranes and structures.

In general, the book is intended as a textbook and pocket manual on geology from the field point of view. As a pocket manual, it is compact and easily readable. In keeping with the field selected, the treatment of the subject is practical throughout, especially in discussing the recognition and interpretation of geologic structures and topographic forms, where it is empirical wherever possible, rather than genetic. A feature is an 18-page table of contents, in which the author skeletonizes the book in a way that greatly facilitates reference to it; this in addition to the usual index. The volume is well and clearly illustrated.

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MODERN STEAM TURBINE. By Prof. Dr.-Ing. E. A. Kraft. English Edition. Berlin: VDI-Verlag G.m.b.H.

Dr. Kraft's volume is an interesting and valuable presentation of modern tendencies in turbine design in the United States and Europe, and may be considered a guide and instructor to those engaged in turbine design and operation, and a helpful handbook to the student and young engineer. The modern trend of turbine design and construction, based on the present knowledge and experience, is elaborately treated in Part I; Part II discusses plants and units of various origin, to illustrate the correctness of the basic principles of design and construction, and also offers comparison between the high pressure and geared units and the giant turbine of today of both European and American make. In addition, particularly valuable to the practical turbine engineer, are curves and graphs on steam pressures and temperatures, the illustrated construction methods employed by the different turbine manufacturers of international note, and the study of materials and turbine efficiencies.

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SILICOSIS: SERIES F, INDUSTRIAL HYGIENE, No. 13. *International Labor Office, League of Nations. London: P. S. King & Son; 16s. Boston, Mass., U. S. A. World Peace Foundation; $4.*

This impressive volume contains the reports of the meeting of the International Labor Office of the League of Nations held at Johannesburg, Transvaal, during August, 1930, together with the papers presented, of great factual and geographical variety. A vast amount of information is scattered throughout the 692 pages, on the status of the silicosis hazard, the steps being taken to reduce incidence and effect cures, and in general to mitigate the harmful effects of the inhalation of silica. It is illustrated by excellent photomicrographs.

TREATISE OF LEATHER BELTING. *By G. B. Haven and G. W. Swett. Technical Composition Company, Cambridge, Mass. Pages 249. Price $1.50. Also published by the American Leather Belting Association, New York, N. Y.*

In this handbook, the topics dealt with are: leather manufacture, physical properties of belting leather, methods of manufacture of leather belting, belting practice, installation and care of leather belting, leather belts on motor installations, belt-drive engineering, belt research, and specification and inspection. The concluding chapter is devoted to tables, nonographs, and plots. The authors, who are both of Massachusetts Institute of Technology, offer the book in the hope that it may lead to a better appreciation of leather belting as a transmission medium and that it will result in more intelligent understanding of its proper application and use.

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RHODESIAN MANUAL ON AGRICULTURE, INDUSTRY AND MINING. *Pp. 1,023; illus. Johannesburg: Mining and Industrial Publications of Africa, Ltd., P. O. Box 7,375. Price: 21s. Inland; 23s. Overseas.*

A complete list of Rhodesian mining companies, together with such details of their production, capitalization, equipment, and extent as is presented in this volume. Its usefulness to the mining engineer interested in Central Africa is enhanced by the detailed descriptions of available transportation and supply facilities. Sections on the Union of South Africa and Portuguese East Africa give an idea of the means by which copper from the new Rhodesian deposits can be shipped and industrial supplies provided.

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ELEMENTS OF ENGINEERING-GEOLOGY. *By H. Ries and T. L. Watson. Second Edition. Pp. 411; illus. New York: John Wiley & Sons; $3.75. London: Chapman & Hall; 18s. 9d.*

This is more than a condensation and simplication of the larger text "Engineering Geology," which the authors brought out in 1914, the preface states. Many parts of the large book have been completely rewritten and other parts have been amplified. It is expected that the new book, because of its smaller size, will be better suited to the requirements of briefer courses in many colleges. The 400 pages of text are divided into fourteen chapters. The topics of some of these chapters are: Rocks and Their Relation to Engineering Work; Rock Weathering and Soils; Development, Work and Control of Rivers; Origin and Relation of Lakes and Swamps to Engineering Work; Geology of Dams and Reservoirs; Road Foundations and Road Materials; and Ore Deposits.

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DETERMINATION OF THE OPAQUE MINERALS. *By C. Mason Farnham. New York: McGraw-Hill Book Company; $3.50. London: McGraw-Hill Book Company, Ltd.; 17s. 6d.*

This is a handbook to help those working with the metallographic microscope in identifying opaque minerals in polished sections, in the course of studying ore deposits. Of the 261 minerals thus far classified as opaque, all are described, although many are rare and 93 are shown by the microscope to be either mixtures or doubtful Fifty-one minerals which are somewhat transparent have been included, either because they are ore minerals or are closely associated with ore deposits. The descriptive data are prefaced by a brief account of the technique of preparing and examining polished sections. The work involved in preparing the data given was completed in the laboratories of the Massachusetts Institute of Technology.

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MINERAL RESOURCES OF THE UNITED STATES, 1928. *Part I—Metals. By Frank J. Katz. Obtainable from the Superintendent of Documents, Government Printing Office, Washington, D. C. Pp. 910. $1.50. Part II—Non-metals. Pp. 801. $1.25.*

All important metallic and non-metallic minerals of the United States are statistically covered in these volumes. Occurrences, operating activities, marketing and development of consumptive demand have been treated. Lists of producers, appended to some of the chapters, should be particularly valuable. Numerous tables and graphic illustrations are also included.

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METAL STATISTICS, 1931. *Twenty-fourth annual edition. Edited by B. E. V. Luty and N. J. Langer. New York: American Metal Market. $2.*

This useful reference book, containing chiefly statistics on production and price of iron, steel, and non-ferrous metals and alloys, is now brought up to date by the inclusion of 1930 data. The usual arrangement has been followed in the current edition, of 552 pages, but every year a few additional topics are covered. The prices are those of the *American Metal Market.* A buyers' directory of ores, metals, alloys, and metal products is the concluding feature of the book, occupying some 60 pages.

ENGINEERING METALLURGY. *Second Edition. By Bradley Stoughton and Allison Butts. New York: McGraw-Hill Book Company. Pp. 497; $5. London: McGraw-Hill Book Company, Ltd.; £1.*

Progress in the metallurgical industry during recent years has made a revision of this book necessary. The material dealing with chemical and extractive metallurgy has been consolidated in one chapter. Heat-treatment of metals and alloys and the theory of alloys have been discussed at greater length. The subject of welding has been extended, and the chapter on testing and examining metals has been rewritten. Technical information and statistics have been revised up to 1929, and many new illustrations and diagrams have been added.

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PSYCHOLOGY OF THE INVENTOR. *By Joseph Rossman, Washington, D. C.: Inventors Publishing Company; $3.*

This treatise supplies a picture of the mental life of the inventor, why and how he invents, how he gets his inspirations, whether inventors are born or made, and other topics. Observations of many inventors are quoted. Important features of the book include an analysis of the mental operations of the inventor in terms of his own reactions and emotions; a description of the actual methods used by inventors; their trials and tribulations; their attitudes and opinions on the material side of inventing; their relation to the promoter and the purchasing public; and their experiences before the Patent Office and in litigation before the courts.

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DIGEST OF MINING LAWS OF CANADA. *Ottawa: Mines Branch of the Department of Mines. Report No. 713, available on application to the director.*

These synopses are intended merely as a general guide to the principles underlying the administration of the laws governing the mining industry in different parts of Canada.

Received

REGULATIONS OF THE MEXICAN MINING LAW. *Issued by the National Chamber of Mines of the State of Chihuahua, 604 Ocampo Ave., Chihuahua, Mexico. Pp. 75. Price, postage prepaid and c.o.d., $2.50.*

ANNUAL STATISTICS OF HUNGARY. *New Series 37. Compiled and Published by L'Office Central Royal Hongrois de Statistique. Pp. 374. Budapest: La Société Anonyme Athenaeum. 6 pengos.*

ECONOMIC HANDBOOK OF THE SOVIET UNION. *New York: American-Russian Chamber of Commerce. Pp. 451; statistics; maps.*

Personal Notes ..... Comment .... Criticism

F. G. Huycke is inspecting properties in the Sudbury Basin district.

O. M. Kuchs, general manager of Andes Copper, was a recent visitor at Inspiration, Ariz.

C. Carleton Semple has returned from the Transvaal, South Africa, and is now in New York.

J. V. N. Dorr expects to return to New York from California via Trail, B. C., about the middle of August.

R. E. Tally, vice-president of United Verde, is at Jerome, Ariz., for a few weeks.

A. D. Storke sailed from New York on the "Mauretania," on July 22, after a two weeks' business visit.

Alderson & Mackay, consulting mining engineers, announce the removal of their headquarters to 500 Dominion Square Building, Montreal, Canada.

James I. Moore, Jr., advises of a change of address from Lakeside, Lake Chelan, Wash., to Mabana, Island County, Wash.

Nelson Dickerman, mining engineer with Yuba Associated Engineers, has returned to the United States from a trip to the Orient.

J. N. Ong, formerly chief of the concentration department at Rio Tinto, Spain, arrived recently in New York from Europe, and is now in California.

Dr. Richard A. Parker announces the removal of his headquarters from 911 Equitable Building to 120 Franklin St., Denver, Colo.

A. A. Friedman, formerly mine foreman with Nurupi Kozan Kabushiki Kaisha, is now on the engineering staff of Searchlight Gold, Searchlight, Nev.

Russell Gibson, instructor in geology, Harvard University, will spend the summer in northwestern Montana, examining mines and prospects.

Charles W. Wright, chief engineer of the mining division, United States Bureau of Mines, recently in Juneau, Alaska, will visit San Francisco on his return.

E. F. Hancock has been appointed mine and mill superintendent of the I. B. Mining Company, of Bannack, Mont., succeeding **C. W. Stallings** and **W. H. Gaines,** resigned.

Dr. Nelson W. Taylor is conducting X-ray research at the University of Utah in connection with the work being done by the Utah Engineering Experiment Station on mineral physics.

R. H. Goodwin, manager of Karkohe Development, Ltd., operating a quicksilver property in New Zealand, has returned from the United States to his post after an inspection of American methods of ore treatment.

George K. Williams, whose work in connection with the design of a copper refinery for Tréfileries & Laminoirs du Havre is approaching completion, expects to return from France to Anaconda, Mont., in August.

Dr. T. A. Rickard has left Berkeley, Calif., for Victoria, B. C. After a short visit, during which he expects to finish proofreading his new book on mining history, he will proceed to St. Jean de Luz.

Dr. Theodore Simons, who was mentioned in our last issue as having been honored by the Montana School of Mines at its recent commencement ex-

ercises, was presented with the nonorary degree of Doctor of Engineering at that time. This is the highest honor the school can confer.

Charles E. Stuart, member of the firm of Stuart, James & Cooke, consulting mining engineers, who recently returned from Russia, said that although it will be many years before the Soviet standard of living approaches that of the American worker, conditions there are steadily improving.

Curry S. Prescott, president and general manager of the Prescott Pump Company, Menominee, Mich., and **Frank J. Smith,** general manager of the Oglebay, Norton iron mines in the Iron River and Crystal Falls district, have been reappointed members of the board of control of the Michigan College of Mining and Technology.

John F. Thompson has been appointed vice-president of The International Nickel Company of Canada, Ltd., following John L. Agnew, deceased. J. C. **Nicholls,** formerly general manager, at Copper Cliff, has been appointed assistant to the president, at Toronto. **Donald MacAskill,** formerly manager of the Mining and Smelting Division, has been made general manager.

Among contributors to this issue:

J. B. Nealey will be remembered as the author of an article in a recent issue, on "Mechanical Mining and Treatment of Sulphur."

A. M. Gaudin, in an abstracted article in this issue, has met an insistent demand for a summary of facts in regard to flotation reagents, of help to those who are interested or who wish to become interested in the subject, rather than for the expert. Mr. Gaudin is research professor of ore dressing at the Montana School of Mines, University of Montana, and the author of a textbook on flotation practice now in preparation for issue.

Dr. A. S. Adams has served on the faculty of the department of metallurgy, Colorado School of Mines; **S. M. Kobey**, a graduate of the same school, has gained experience in metallurgical work with the San Francisco Mines and United Verde Extension companies; **M. J. Sayers,** also a C.S.M. alumnus, has specialized in research on iron-ore concentration by flotation—the subject on which he and his associates contribute an article in this issue.

Richard W. Smith, assistant state geologist of Georgia, and formerly assistant geologist of Tennessee, who contributes the article "Geology and Origin of the Phosphate Deposits of Tennessee," presents some interesting and new data, based on microscopic evidence, concerning the origin of the Tennessee phosphates. He will be recalled as the author of "The Phosphate Rock Industry of Tennessee," which appeared in *Engineering and Mining Journal* for Feb. 3, 1923.

Russell B. Woakes was born in the Republic of Colombia, educated at Bedford, England, and the Royal School of Mines, London, at which he gained an associateship in 1910. Post-graduate work followed in the Kolar gold field, in India, leading to a staff appointment at the Nundrydroog mines. Distinguished war service in Mesopotamia, 1915-19, was followed by a return to professional work, at the Mysore mines. Followed association with the Cordoba Copper Company, afterward renamed the Indian Copper Corporation, as mine manager, superintendent, and general manager (in 1927), when the Anglo-Oriental company took over the administration from John Taylor & Sons.

A. E. Northey, director of Cia. Asfaltos de Cuba (Mariel) S. A., and general manager of the asphalt property described in a recent issue, comes of a typical Cornish mining family, whose parish is the world of mining. His grandfather and uncle were among the 'forty-niners. He himself, educated in Wales (University College), has practiced his profession in lead-silver and zinc mines in Cardiganshire, Wales, and Derbyshire, England; in charge of a silver property in the Republic of Colombia; as manager of tin and wolfram mines in the Province of Zamora, Spain, owned by William Willett, of daylight-saving fame, and of copper mines in the Province of Coruña; as mining consultant to the Foreign Office, London, and to Spanish, English, and American interests.

H. J. C. MacDonald is chief mining engineer consultant of the Giprosvetmet in the projection, administration, and exploitation of mines and plants in the U.S.S.R. Mr. MacDonald is also chief mining engineer consultant to the Zvetmetzloto, the control organization for all the mining trusts, and a member of its technical council. This announcement will serve to correct an error in a recent issue of this publication, based on an item sent in by our correspondent at Houghton, Mich., in which another employee of the U.S.S.R. was said to have been advanced to the post of "chief engineer of the projecting branch for all non-ferrous mining undertaken in the U.S.S.R." Apologies are tendered to Mr. MacDonald for an unintentional slight.

Steel Treatment in British Columbia

To the Editor of "E.&M.J.":

I have read with pleasure the interesting article on the Sullivan mine of Consolidated Mining & Smelting, Kimberley, B. C., in the March 9 issue. A few comments and corrections are necessary, however. The size and quality of the steel used (vanadium steel, 1¼ in., hollow round) is correct, but the name of the maker should have been Cammell Laird & Company, Ltd., Sheffield, England. Incidentally, I may say that since this steel was used the mining cost per ton for steel has been reduced over 50 per cent. On page 217 reference is made to an electric furnace installed at one of the principal underground stations on the adit level. This furnace was originally designed by Mr. Albert G. Cutts, of Verdon Cutts & Company, Ltd., Sheffield, for a mining company in South Africa. I happened to be in Sheffield four years ago and saw the results of operation of this furnace in South Africa, and knowing that Mr. W. M. Archibald required a suitable electric furnace for underground use for the Sullivan mine, I got in touch with Mr. Cutts and obtained blueprints and specifications of his furnace, which I forwarded to Mr. Archibald. On my return to Vancouver he placed an order for the furnace, which is now operating in the Sullivan mine. In the meantime, however, Verdon Cutts & Company had been absorbed by the General Electric Company, Ltd., of London, England, which completed and supplied the furnace. The Consolidated company installed the furnace from plans supplied by the General Electric Company, to some extent under our supervision.

It is only fair, however, to state that, although the principle of the furnace remains the same, the general design has been altered by the mechanical staff of the Sullivan mine to suit local requirements. As the article points out, the use of the electric furnace removes one of the principal objections to underground tool-sharpening shops. The experience with such an installation will be of great technical interest and economic value in the handling of drill steel in British Columbia mines.

Vancouver, B. C. N. THOMPSON,
English Steel Corp., Ltd.

Extraction and Recovery of Gold

To the Editor of "E.&M.J.":

In the issue of June 22 appears an editorial on the relative merits of amalgamation plus cyaniding versus straight cyaniding, and an assumption is made in favor of amalgamating which is not justified by results from practice.

The statement was made: "If a proportion of the gold in an ore is amalgamable, almost 100 per cent of this proportion is recoverable. If cyanidation replaces amalgamation as a treatment process for this proportion, *only from 90 to 95 per cent is usually recovered.*"

In most free-milling gold ores there seems to be from 25 to 30c. per ton which is not recoverable commercially, due to the cost of grinding the pulp to a degree of fineness which will expose the minute particles of gold to treatment. This gold is not profitably recoverable either by cyaniding or by amalgamating. Another part of the gold is too dirty, largely due to adhering gangue, to be caught by amalgamation, but most of this portion is easily cyanided. The remainder is your 100 per cent amalgamable gold, but this is also 100 per cent cyanidable. This contention is borne out by practice, for ores treated by cyanidation show about the same tailing losses as do ores treated by amalgamation plus cyanidation. The question thus becomes one of operating costs, from crushers to tailing discharge, and upon this basis it seems impossible to justify the added cost and effort due to the extra step of amalgamation. The fallacy lies in assuming that cyanidation will extract only 95 per cent of the gold caught by amalgamation.

I recently checked over mill returns from a property using straight amalgamation. The owners were quite satisfied they were getting from 87 to 90 per cent extraction because laboratory tests at a certain mining school showed this to be possible with their ore. Screen tests showed 64 per cent through 150 mesh, which should have made good extraction possible, yet the tailing was carrying 30 per cent of the gold (and all the hoped-for profit) down the creek. P. A. ROBBINS.

Highland Park, Ill.

[An unsuitable process, or the imperfect or inexpert direction of a suitable process, has been responsible for many failures. The contention criticized—that amalgamation plus cyanidation may give better technical results than straight cyanidation—was based on practice as well as principle. Cyanidation may extract as much gold as can be caught by amalgamation; but the commercial recovery of gold from an auro-cyanide pulp, by decantation or filtration and solution displacement, precipitation of the gold by zinc, treatment of the precipitate, and the smelting of the resulting product cannot normally be so complete as is the recovery of gold by retorting amalgam and melting the "sponge."—EDITOR.]

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Obituary

Joseph B. Tomlinson, pioneer in the development of mining in the Southwest, died early in July at the home of a son in Prescott, Ariz. He was 73 years old.

Charles Trezona, general superintendent since 1902 of the Vermilion Range mines of Oliver Iron Mining, died on June 21, in Duluth. He was 68 years of age.

Philip Saunders, first discoverer of gold in the Kimberly area of Western Australia, died recently at Kalgoorlie, at the age of 90. He had enjoyed a pension from the state as a reward for the part he played in its early mineral development.

Dr. Edward Goodrich Acheson, metallurgist and inventor, died in New York on July 6, after a short illness. Dr. Acheson's most widely known discovery is carborundum. He will be remembered also as an expert in electric furnace construction. He was 75 years of age.

Dr. Arthur Starr Eakle died in Honolulu on July 5, at the age of 69 years. Dr. Eakle was a graduate of Cornell University, and received his doctor's degree at the University of Munich. In 1900 he became professor of mineralogy at the University of California. Two years ago he became professor emeritus of mineralogy, and since then had interested himself in various economic problems.

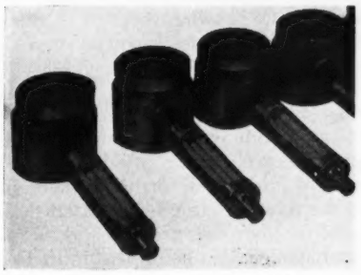
Frank Powers, who died at the age of 80 years on June 25 at his home in Patagonia, Ariz., was one of the pioneer miners of the Southwest and was well known in the mining districts of Utah, Colorado, Nevada, and Arizona. He located and filed on what later became the World's Fair mine, near Patagonia. This mine was one of the richest silver properties in the State. Mr. Powers was noted for his open-handed charity to the men of his profession who were "down on their luck" and provided food and lodging for many of them when he was unable to give them employment.

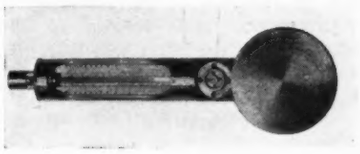
John Lyons Agnew, vice-president of International Nickel, died at his home in Copper Cliff, Ont., on July 8, after a brief illness. He was in charge of the company's operations in both Canada and Great Britain, and had recently returned from an inspection trip to England. Born in Pittsburgh, Pa., in 1884, he went to Canada at the age of 19, and joined the staff of the Canadian Copper Company in 1904. He worked his way through many positions, finally becoming general superintendent of Canadian Copper. In 1929, with the formation of International Nickel, he became vice-president of the new company.

Dr. John F. Thompson, assistant to the president of the company, has made the following statement in relation to Mr. Agnew's services and career: "Although Mr. Agnew had no university education, he built up on the basis of a remarkable memory, tireless energy and native ability, an international reputation as an authority in mining, metallurgical and engineering operations. As general superintendent of the Canadian Copper Company during the World War, he made restricted production facilities turn out a phenomenal amount of the nickel so badly needed in making munitions of war for the Allies. Again, he showed his energy and executive ability in keeping up output during the last six years when he directed both the production and the development programs of the company. To the mining world the Frood mine and Copper Cliff smelter will be his monument. His associates in this company will remember him rather for his unfailing courage and optimism shown throughout his long association with them."

INDUSTRIAL PROGRESS

Ground Pressure and Movement Indicated by Two New Devices



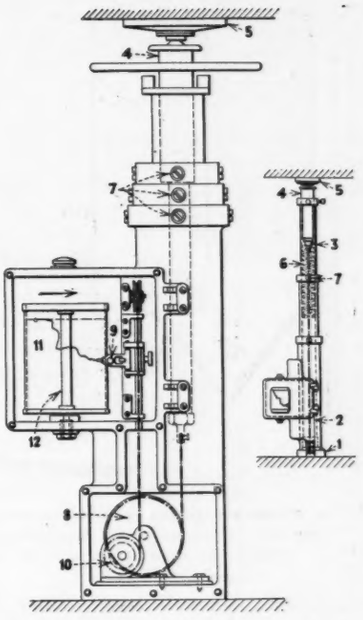


The illustrations above and below show a device developed for measuring rock pressure

SAFETY in mining calls for the determination of ground pressure and movement in underground workings. To facilitate such determination, the Losenhausenwerk company at Düsseldorf-Grafenberg, Germany (Losenhausenwerk Düsseldorfer Maschinenbau, A.G.), has recently introduced for use in mine work the two devices described in the following:

The device for measuring rock pressure is an apparatus similar to that already used in various forms for measuring high pressures and has been developed in a form convenient for mine use. It is shown in two cuts. It consists principally of a closed hollow receptacle filled with mercury and connected to a glass tube. A pressure plate on top of the device serves to communicate the pressure of the moving ground to the mercury, the position of which may be read on the scale in the glass tube. The higher the pressure, the further the mercury rises on the scale. The apparatus is so calibrated that each position of the mercury column corresponds to a definite load. To eliminate errors due to temperature and other causes, a correcting device is provided, whereby the mercury column can be brought to the normal position. When this is done the apparatus is ready for use, and is said to register the load exactly. The low height of the device, about 5 in., makes it easy to insert it between the post or cap of a drift set and the ground it is supporting.

The second device referred to registers the amount of sinking of the roof of a mine working during a certain period of time. It is illustrated in the line drawing at the right, to which the following numbers refer. The device consists of a foot plate (1), with an upright cylinder (2) having an indicating and registering mechanism on the side. Within the cylinder are several telescoping tubes which may be adjusted to conform to the height of the roof above the foot. Within the upper tube (3) is a piston (4), which is extended a distance corresponding to that between the roof and the foot. This piston carries on its upper end a pressure plate (5), mounted on ball bearings. A spring (6) in the lower part of tube 3 presses the piston upward. By means a tension device (7), the individual telescoping tubes are prevented from telescoping until a certain pressure is reached. When the ground above the piston starts to sink, the piston is pressed back into the tube, compressing the spring. When the spring is completely compressed, the tubes will begin to telescope. Through the tube from the piston a string runs to a cylinder (8), actuating a second string and another cylinder (10). As soon as the spring is completely compressed,



Device for registering amount of sinking of roof

cylinders 8 and 10 begin to function, and the recording pen (9) is moved proportionally. Normally, the piston has a range of 40 in., a corresponding movement of the pen being 4 in., in accordance with a gear ratio of 1 to 10. The pen records on a third cylinder (11), actuated by a clock movement.

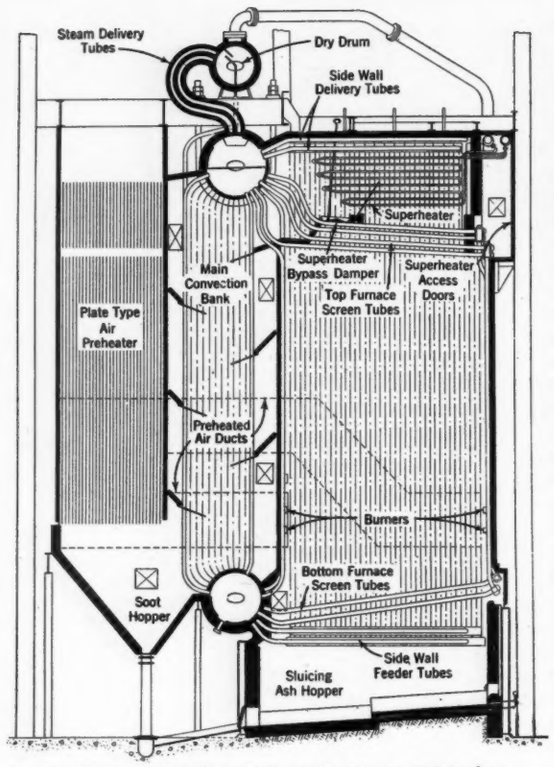
■ ■

New Equipment Ranges From Protective Cap to Steam Generator for Small Plant

With Much of Interest for the Shop

THE latest model of protective headgear developed primarily for the mining industry is shown in a cut presented herewith. It is a cap, known as "Skullgard," made by the Mine Safety Appliances Company, Pittsburgh, Pa. The shell is of micarta, molded in one solid, seamless piece, proof against softening or changing size, the crown being reinforced to afford effective protection against head injuries. The entire cap is a non-conductor of electricity, is durable, waterproof, acid-resisting, and built for long service. A rigid peak protects face and eyes from falling materials. To protect the ears the reinforced edge of the cap is flared. The lamp holder is substantial and can be arranged to accommodate any type of lamp. Comfort is provided by means of a soft, tough, sweat-proof leatherette lining, cushioned with felt pads. The crown has holes for ventilation. The

The latest in protective headgear for miners



A steam-generating unit designed in eight sizes, capacities ranging from 70,000 to 400,000 lb. of steam per hour, from and at 212 deg. F.

cap is light and well balanced and will not tip forward in any normal working position. It may be had in sizes 6 to 7⅝.

A Standard Steam Generator

A standard steam-generating unit, built in various sizes and providing a wide range of capacities at any desired conditions of steam temperature and pressure, has been developed by Combustion Engineering Corporation, New York. It is shown herewith in a cut. Detailed designs have been completed for eight sizes with capacities ranging from 70,000 to 400,000 lb. of steam per hour, from and at 212 deg. F. In a single unit are combined all elements needed for fuel burning, steam generation and superheating, heat recovery, and ash disposal. No radical departures from fundamentals are made. All pipes and headers for completing the circulating system of the water walls are entirely within the casing, serving to increase the heat-absorbing surface. The casing is without openings. All four walls are water cooled. The corner-tangential system of firing, producing intense turbulance with extreme rapidity of combustion and correspondingly high temperatures, is used.

Measures Variable Air Flow

A meter that will give accurate measurements of the flow of compressed air and gas, independently of changes in pressure, temperature, specific gravity, or in the nature of the flow, has been developed by the Askania Werke A.G., Berlin-Friedenau, Germany, it is claimed. This company is represented in the United States by the American Askania Corporation, of Houston, Texas, and Chicago.

Measurements are read direct.y in terms of atmospheric pressure and temperature. The meter bypasses from the main flow a volume which is always in a fixed ratio to the latter. This bypassed flow, at atmospheric pressure and temperature, is then measured with the usual instruments. A measuring resistance is built into the main (Fig. 1) in which the flow is to be measured. It may be in the form of an orifice plate, a nozzle or a Venturi tube. The resistance results in a pressure differential ($p_1 - p_2$) which serves as actuating impulse. The measuring connections are joined to the so-called flow deviator, which has two chambers, n and o, separated by a sensitive featherweight diaphragm, which is connected to a small outlet needle valve, q. The measuring connection (p_1) in front of the orifice plate leads to chamber o and the other connection (p_2) leads to n. In these

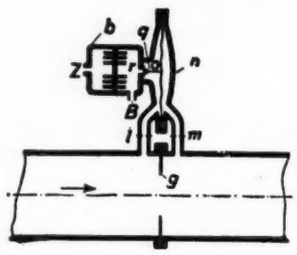


Fig. 1—Diagram illustrating the measuring principle

connections are two small orifice plates, l and m, equal in size, m serving to synchronize the filling of chambers n and o, and to prevent overloading one side of the diaphragm when the flow is first started or any sudden change in the pressure occurs. As soon as air or gas starts to flow through the main pipe, pressures p_1 and p_2 are established and communicated to the diaphragm. Pressure p_1, in chamber o, being greater than p_2, deflects the diaphragm to the right, opening valve q, until sufficient volume of air or gas has escaped through it to equalize the pressure at p_2 in the two chambers o and n. The effect of this is that in front of orifice plates g and l (reading in the direction of the flow) the pressure (p_1) is the same, and behind g and l the pressure (p_2) is also equal. The two orifice plates are accordingly subjected to exactly the same conditions of flow, the differential pressure as well as the static pressures and the temperatures being the same at both points; the constants which apply are therefore equal in both cases, so that a definite proportion of the total flow carried by the main pipe passes l, such proportion being governed by the relation between the two resistances opposed to the flow. The dimensions and calibration of the orifice plates l and g are so arranged that the volume of air or gas passing through l shall be 1/500, 1/1,000, 1/10,000, or 1/100,000 of the main flow passing through g, or any convenient fraction which serves the purpose best.

In order that the same flow deviator may be used at different measuring points (even with different pipe diameters) as well as for any desired volume of flow, the small orifice plate l fitted to the flow deviator is constructed as an "orifice plate cartridge" and is made interchangeable, being calibrated with extreme precision so that it has a definite "passage value," whereas the orifice plate g which fits into the main pipe is adapted to the existing local requirements and conditions. The dimensions of the latter will then govern the relation between the main and the by-passed flow which may be called the "orifice plate factor."

The by-passed flow passing over the orifice plate l and through the needle valve q is measured, and only needs multiplying by the orifice plate factor for the volume of the main flow to be ascertained.

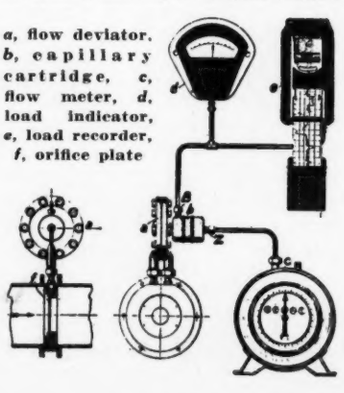
Three methods of indication may be used: Progressive indication of volume, *i.e.*, ordinary meter counting; indicating momentary flow; and recording the volume of air or gas passing at any given moment.

Small Efficient Coal Pulverizer Uses Ball and Ring Principle

A new coal pulverizer, Type C, has been developed by Fuller Lehigh Company, 85 Liberty St., New York, for small and medium-sized industrial boiler plants. Its design embodies the ball-and-grinding-ring principle of pulveriz-

Fig. 2—Diagram showing a complete stationary flow-measuring installation

***a*, flow deviator, *b*, capillary cartridge, *c*, flow meter, *d*, load indicator, *e*, load recorder, *f*, orifice plate**



ing, which renders the degree of fineness of the pulverized coal independent of the wear of the grinding parts. The coal is pulverized by large balls grinding under pressure between upper and lower grinding rings. The pressure is maintained by a heavy steel spring and can be adjusted to suit the hardness of the coal. This grinder will pulverize wet coal, if pre-heated air be used for separating the fines. It may be had in several sizes and in capacities ranging from 1 ton to 6 tons of coal per hour.

Weighing Scale Improved

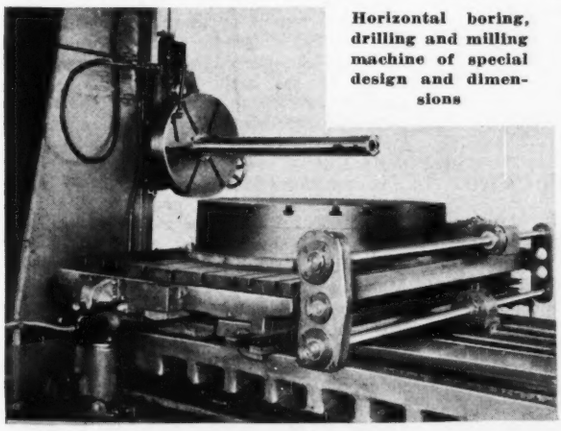
Scale construction has been so improved by the Toledo Scale Company, Toledo, Ohio, that it is now possible to replace and interchange pivots and bearings in a heavy-duty scale with little or no loss of time. On a recent test such interchange was made within ten minutes, and the indicator is said to have split the line on every test. Formerly each pivot had to be honed carefully and checked repeatedly with gages.

Largest Clutch Facing

What is claimed to be the largest friction clutch-facing of asbestos in the world has been made by the Manhattan Rubber Manufacturing Division of Raybestos Manhattan, Inc., Passaic, N. J. It measures 154 in. in diameter and has a 12-in. face. Four clutch facings of this type are to be used on a mine-hoist clutch specially designed by a large Southern company.

An Interesting Machine Tool

An accompanying cut shows a special horizontal boring, drilling, and milling machine developed by Joseph T. Ryerson & Son, Inc., Chicago, in conjunction with the Ohio Machine Tool Company, Kenton, Ohio. Its weight is 60,000 lb. The diameter of the spindle is 5 in., the continuous feed to the spindle 36 in., the reset to the spindle 40 in., the working surface of the table 60x96 in., with a cross feed of 94 in. The maximum distance between top of table to center line of spindle is 85½ in., and the maximum distance of the face plate to the bar support is 168 in. Eighteen speeds, all reversible, are obtainable. Eight boring and drilling feeds and sixteen milling feeds to the head, table and table saddle, reversible, are furnished.



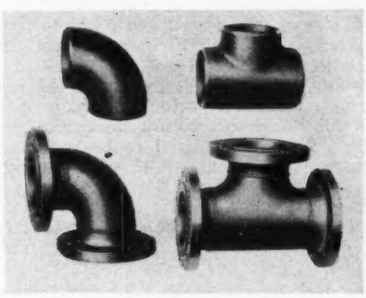
Horizontal boring, drilling and milling machine of special design and dimensions

World's Record Claimed

Steel bands, intended primarily for steel belt conveyors but used for other purposes also, are being made by the Sandvik Steel Works, Sandviken, Sweden, up to 32 in. in width. The company's plant has recently rolled a cold-rolled and hardened-steel band 32 in. wide, 360 ft. long, and 0.0472 in. thick. As to width, it is claimed this represents a world's record in cold rolling and hardening. The company is a pioneer in making bands of such large width. In the last few years the width has been increased from 18 to 24 in. and now to 32 in.

This Pump for General Use

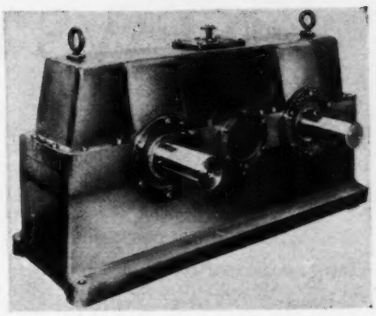
A centrifugal pump, for which good efficiency, low initial cost, and low maintenance expense are claimed, has been introduced by Worthington Pump & Machinery Corporation, Harrison, N. J. It is the Monobloc Type D unit. The pump is simple and sturdy, is bolted to the extended motor frame, with the impeller mounted on the end of the continuous motor shaft. The impeller is of bronze and has the shaft sleeve as an integral part. It may be locked by a special cadmium-plated steel device.



Part of a complete line of seamless steel pipe fittings for welding, recently introduced

Pipe Fittings for Welding

A complete line of seamless steel pipe fittings for welding has been developed by the Taylor Forge & Pipe Works, Chicago. It consists of elbows, tees, reducing tees, bull plugs, and reducing nipples, as well as Taylor forged-steel butt-welding flanges. At present only sizes 12 in. and smaller are available, but eventually the fittings will be obtainable up to 24 in. The tees are made in 2-in. to 8-in. sizes. These fittings permit entire pipe systems fabricated by welding to be installed with only the use of true circumferential welds, which are said to be the easiest to make, thus resulting in increased efficiency of the welder and full-strength welds. Some of the fittings are shown in an accompanying cut.



The casing of this speed reducer is of welded rolled steel

Reducer Housings Welded

A new development of Philadelphia Gear Works, Philadelphia, Pa., is a line of speed reducers in welded rolled-steel casings, which are 75 to 100 per cent stronger than the usual type. One of these is here shown. Thus protected, these reducers are said to be practically immune to accidents. Dust, dirt, moisture, acid fumes, and other external dangers are also sealed out.

New Speed Reducers

A new series of small herringbone-Maag speed reducers has been developed by the W. A. Jones Foundry & Machine Company, 4401 W. Roosevelt Road, Chicago. Capacities range up to 18 hp. and reduction ratios from 12 to 1 up to 48 to 1. The smallest of the series is 20⅝ in. long and 14¼ in. high.

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Industrial Notes

International - Stacey Corporation, Columbus, Ohio, has closed its San Francisco office and has transferred E. A. McCallum to the company's Pacific Coast headquarters at 410 Subway Terminal Building, Los Angeles.

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Bulletins

Truck Bodies. Easton Car & Construction Company, Easton, Pa. Bulletin No. 40. Truck bodies for quarry and mine service.

Condensers. Elliott Company, Pittsburgh, Pa. Bulletin C-7. Surface condensers.

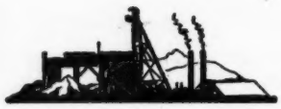
Piping. Taylor Forge & Pipe Works, Chicago. Catalog No. 31. Taylor forge-welded pipe.

Speed Reducers. W. A. Jones Foundry & Machine Company, 4401 W. Roosevelt Road, Chicago. Descriptive book and catalog covering worm-gear speed reducers.

Flotation. Galigher Company, Salt Lake City, Utah. Booklet No. 1931-F. The Geary feeder for liquids.

Sampling. Galigher Company, Salt Lake City, Utah. Booklet No. 1931-S. The Geary-Jennings sampler.

NEWS OF THE INDUSTRY



Itogon Mining Will Drive New 7,000-Ft. Tunnel

Itogon Mining, third largest gold producer in the Baguio district of the Philippine Islands, will drive a new 7,000-ft. tunnel at its property. This tunnel is expected to tap the orebodies 1,200 ft. below the present workings. Profits from present operation will be used entirely for financing this project, in the hope that it will develop sufficient ore to justify a new and larger mill.

At present, Itogon is handling about 5,000 tons of ore monthly in a plant that has been remodeled from an original capacity of 1,000 tons a month and which was obtained from the old Headwaters mine in 1926. At that time, the company had developed ore in the Taka vein system through a 600-ft. tunnel, which is still the principal operating working. Although the plant was originally an amalgamation unit, recovery was so low that cyanidation equipment was added.

Mine development has been very favorable, ore grade averaging between $12 and $14 in gold per ton. A new power unit has been installed to run the mill equipment. It consists of a 220-hp. Swedish Atlas diesel engine, coupled to a 440-volt a.c. generator. The old power units are being used to furnish power for a new 670-cu.ft. air compressor.

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Tonopah Hasbrouck Acquires Claims in Scossa Area

Tonopah Hasbrouck Mining has taken over the Golden Locks group of five claims in the Saw Tooth Range, Scossa mining district, Pershing County, Nev. Four well-defined gold-silver ledges traverse the claims. Surface exploration is to start at once under the personal direction of W. B. Worlock, president. The four veins will be trenched from end to end. When this work is completed a shaft may be put down. Tonopah Hasbrouck has a considerable amount of machinery, including one 50-hp. and one 25-hp. gasoline engine, ore cars, rails and tools, headframe, and surface buildings all at its Quartz Mountain property.

Shortly after the death of the former president of Tonopah Hasbrouck, A. A. Codd, Mr. Worlock, of Los Angeles, and associates purchased the Codd interest from the estate. This with other stock purchased gave Worlock and associates control of the company.

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Hollinger Options Sudbury Claims

Hollinger Consolidated Gold Mines is reported to have taken a sampling option on a group of claims known as the Steep-Sheehan property, 10 miles east of Willisville, on the nickel subdivision of the Canadian Pacific Railway, west of Sudbury, Ont. A small staking rush has developed within the last few days in that section, more than 40 claims having been staked and recorded at Sudbury. The formation is largely quartzite, gold being found in association with arsenopyrite.

■

Remance Drifts on No. 6 Level; Mill Recovery 92 Per Cent

The Panama Corporation reports that at its Remance mine, in Panama, Central America, the exploratory drift on the No. 6 level north has advanced 86 ft. toward the gold orebody encountered in the level above, and winze No. 1 on the No. 5 level has been started in the rich area, and for the 50 ft. sunk averages 64s. per ton over 61 in. The north shaft is down to 178 ft., but progress has been interrupted by an influx of water. Pumps are being installed and shaft sinking has been resumed. There are 8,000 tons of broken gold ore in the stopes, and this has retarded operations.

About 500 tons was treated in the mill during June, of a value of 36s. in gold per ton, and extraction was 92.3 per cent. This is expected to be increased soon to 95 per cent. Although the difficulties incidental to the starting of a new plant have restricted milling, the complete mill should be running shortly. From the ore available, an average grade of 40s. in gold per ton is expected to be maintained. This should be increased as the higher values are opened up at depth. At El Mineral and Sabalo no proper clean-up has been made, but at the former 350 cu.yd. washed at face No. 1 gave 23 oz. No. 2 face is being opened up.

■

Gold Strike Near Volcano, Calif.

Lagomarsino Brothers have struck rich gold-bearing gravel in their property near Volcano, Calif. Previous work in the ancient river channel failed to get gold, but investigation of the gravel underlying the adit was successful.

Several large nuggets were found, and preparations are being made for the milling of the more or less cemented gravel now being mined.

■

El Dorado Gold Ships Ore

El Dorado Gold Mining is reopening the El Dorado and Ranger properties, 17 miles from Salmon, Lemhi County, Idaho. One carload of ore has been shipped that assayed $39 a ton, largely in gold. This ore came from the Ranger shoot, which has been opened for a length of 320 ft. An old tunnel, 500 ft. lower, is now being advanced toward the vein and is expected to cut it within 100 ft. The company is considering construction of a small mill.

Student Recovers $1,700 Gold From Placer Operations

Seventeen hundred dollars was earned by Robert J. McRae, 22-year-old mines student, in 45 days during the summer a few years ago before he registered at the University of Idaho. McRae was born and reared in central Idaho, near Thunder Mountain, scene of exciting gold rush days in 1903, '04, '05. He needed money, and the quickest way to get it that he knew was to go placer mining.

With a gold pan he hied himself to the hills, and panned many a sample of gravel. In one small stream the prospects were promising. He followed the traces, and staked a claim on a hillside, several hundred yards from the stream. By packing the gravel on his back to the water's edge, he was able to pan $3 to $4 in gold in a ten-hour day.

Next he built a rocker, and his earnings increased to $15 a day. By hauling the gravel to his rocker with a horse-drawn sled or "go-devil" he added another $10 to his daily profits; but he soon found out that shaking the rocker by hand was slow, back-breaking labor. He cast about for mechanical assistance, and bethought himself of a gasoline drag-saw outfit he might borrow from a mine on the other side of the divide. Borrow it he did, to dismantle it and pack it to his mine on the backs of two mules.

His power plant operated on one gallon of gas per day. He had watched the engine drag a 6-ft. crosscut saw back and forth through a heavy log, and realized that the same eccentric arm motion would work on his rocker. About 200 yards upstream he constructed a dam, and piped water to the plant, which at full capacity would handle 1 cu.yd. of gravel per hour, netting him between $30 and $40 a day. Unable to operate at full capacity alone, he hired a man to haul gravel from the hillside.

Every evening McRae cleaned up, weighed the gold and put it away in half-pint fruit jars. At the end of the summer he sold the gold from seven full jars at the government assay offices at Boise.

That fall McRae entered the University of Idaho, registered in mining engineering. His scholastic average for his first year was 5,766 out of a possible 6,000 for perfect or all "A" grades. That achievement won for him the Sigma Tau medal, presented to the highest ranking freshman engineer in the university. John W. Finch, Dean of the School of Mines, considers him one of the most outstanding men in the school of mines.

Last summer McRae and his father operated a stamp mill at a property owned by the elder McRae. The son's share in the profits for three months was $1,000. He is back on the same job this summer. McRae's life has been spent around a mine. He knew how to wash gravel in a gold pan before he was six years old, and amused himself by panning everything in sight that even looked as if it might contain gold. Once, when he was a six-year-old, he came across a discarded ore sample, panned it, and obtained an ounce of gold.

Tooele Smelter Shut Down; To Reopen in October

International Smelting, subsidiary of Anaconda Copper, operating in Utah and Arizona, has closed its smelter at Tooele, Utah. The plant, which suspended operations on July 15, will reopen on Oct. 1, according to J. O. Elton, general manager. The principal product of the Tooele smelter is lead bullion, although there is also one copper furnace and the custom concentrator recovers a zinc concentrate that is shipped to Montana for electrolytic treatment. From 400 to 500 men were employed at the plant at the time the shutdown occurred. These will be re-employed in the fall in the order of seniority.

Closing of the Tooele smelter will mean a drop of about 3,000 to 4,000 short tons in United States lead production monthly. The 1930 output of the plant was 107,860,121 lb. of lead, 4,543,645 oz. of silver, and 28,300 oz. of gold. The 1930 output was 152,536,672 lb. of lead. Separate figures for zinc-concentrate and copper blister output are not available. The latter runs around 2,000,000 lb. a month, largely recovered from Walker Mining concentrate.

According to the announcement, the company's subsidiaries operating in the Tintic and Bingham districts will not be affected. Utah Delaware and North Lily are the principal Utah mines controlled by International. Arrangements have been made for continuation of operation of the custom concentrator, so as to treat ore from the Tintic Standard property and, presumably, for receipt of ores from other mines as well. The drop in ore supplies is undoubtedly the chief reason for shutting down the plant at a time when the lead situation looks more favorable. Among the mines that supply the Tooele lead unit, Utah Metal & Tunnel has recently closed down, Park Utah Consolidated has been forced to reduce shipments to a few hundred tons a week because of low metal prices and lack of ore, and North Lily has not been able to develop new ore as fast as it mines the known deposits.

As the Murray plant of American Smelting & Refining closed down on July 1, only the Midvale unit of U. S. Smelting is still in operation among Utah lead smelters. According to officials, the company has no intention of closing unless metal prices go considerably lower. With the shutdown of the East Helena smelter, and intermittent operation of the El Paso plant, the only lead smelters still operating regularly in the West in addition to Midvale are Bunker Hill's Kellogg plant, the Arkansas Valley unit of A. S. & R. at Leadville, Colo., and the smelter at Selby, Calif., also belonging to A. S. & R.

■

Reopen Kittie Burton Mine

Operation of the old stamp mill at the Kittie Burton gold property, on Indian Creek, 24 miles northwest of Salmon, Lemhi County, Idaho, will be resumed within two months, according to H. W. Ingalls, of Mullan, Idaho, who is a member of the syndicate that has reopened the property. Only five of the fifteen stamps have been put into condition for operation at present. Old workings have been cleaned out and several new stopes are being prepared. Others interested in the venture are E. D. Hanson, lease operator in the Morning mine, at Mullan; Thomas Boyle, and Arthur Herndon, of Salmon.

The Kittie Burton property consists of a group of seventeen claims, covering the Ulysses and Kittie Burton veins. Development has been done through three tunnels. According to Mr. Ingalls, the veins range from 3 to 36 ft. in thickness. Former operations are said to have yielded an average grade of about $7.50 in gold per ton, with total output estimated at $800,000.

■

To Celebrate Fifty Years of Progress at Bisbee

Bisbee, Ariz., which ranks fourth among the principal copper-producing districts of the United States to the end of 1930, is planning to celebrate its fiftieth birthday on Aug. 1, 2 and 3. Prices totaling $175 have been offered for a single-jack and a double-jack contest. A 4-lb. hammer will be used in the former contest and an 8-lb. hammer in the latter. Steel will be ⅞-in. thick. The time for each contest will be 10 min. Sell Far, a champion driller 25 years ago, will referee the affair. Dr. Clara Judson Stillman, who opened and taught Bisbee's first school nearly 50 years ago, will be present at the celebration, and Frank Hitchcock, Postmaster General under President Taft, will be there to dedicate the airport. Fifty-three floats are being prepared for the parade and fourteen episodes representing Bisbee's past and present have been secured for the pageant of progress.

■

Gold Find in Coeur d'Alene

A strike of high-grade gold ore is reported from the Coeur d'Alene district, Idaho's principal silver-lead producing district. It was made in the old Mother Lode property, which was one of the largest gold producers in the early days of the district. The property is on Prichard Creek, near Murray. Operations have been resumed by J. F. Murphy and Michael Melley. They cut the vein in a tunnel 400 ft. west of the old operating tunnel. After drifting about 40 ft. east along the vein, free gold was cut, and, in an additional 10 ft., a high-grade shoot. The depth is estimated at about 175 ft. below the surface, the vein width at 4 ft., and the width of the high-grade at about 16 in.

■

Eureka Standard Drifts on 1,400

Drifting on the 1,400 level of the Eureka Standard mine, premier gold producer in the Tintic district of Utah and subsidiary of Tintic Standard, has been resumed as a result of the increase in the company's pumping capacity to 1,200 g.p.m. At present, the flow of water is about 400 g.p.m., with a temperature of 135 deg. F. The pumping equipment now consists of a Byron-Jackson deep-well pump which lifts water from the 1,400 level to the 1,300; two Cameron pumps of 600 g.p.m. on that level, lifting to the 800 level; and two similar pumps on the 800 level, lifting to the surface.

About 600 ft. of drifting will probably be necessary to intersect the ore on the 1,400 level. A winze from the 1,300 level is more than 50 ft. below its collar. In the winze, a Cameron No. 9 sinker pump is used.

Curtailment and Wage Cuts at Arizona Copper Mines

Within the last two weeks, word has been received of further curtailment of operations and also of wage cuts at copper mines in northern and central Arizona. The wage cuts were made at Miami, Inspiration and United Verde. No indication has yet been received that similar action will be taken by Phelps Dodge and Calumet & Arizona, leading producers in southern Arizona, or by copper producers in other Western states. Michigan mines cut wages 7½ to 10 per cent in June.

Miami Copper has reduced all wages and salaries by 9 per cent. According to F. W. Maclennan, general manager, the reduction, which became effective on July 16, will bring payments back to the basis obtaining in 1921-22. He said that the step was undertaken in the hope that it would make possible a continuation of operations without a further reduction in the number of men employed. Miami curtailed output one-third in January to a basis of 12,000 tons of ore daily.

Inspiration Consolidated, operating in the same district, is reducing the pay of only such employees as receive $1,800 or more annually. Workers receiving from $1,800 to $3,000 will have their pay cut 5 per cent, and those getting more than that amount, 7½ per cent.

Christmas Copper, Iron Cap subsidiary at Christmas, Ariz., which shut down its 500-ton concentrator several weeks ago, has now suspended all development work. Only four watchmen are employed at the mine. Recent exploration at this property is reported to have opened good ore.

Operations of United Verde Copper at Jerome and Clarkdale, Ariz., are to be curtailed 50 per cent, according to an announcement by W. V. DeCamp, general manager. Reduction of the working force has already been started and will be completed by Aug. 1, by which time 400 men will have been laid off. Operations will be continued with a force of 600 men, most of whom will be at Jerome, where No. 7 shaft work and stripping the pit will be continued. Research work and repairs to the smelter will be continued at Clarkdale. Pay of salaried employees was cut from 10 to 25 per cent on July 1.

Of the other large Arizona producers, United Verde Extension and Magma Copper have temporarily closed down, and they are not therefore confronted with the necessity of taking similar action. The development work in the Haynes claim of U.V.X., which has resulted in opening a new copper orebody (see *E. & M. J.* of July 13, p. 34), is being done through the workings of United Verde Copper and by a crew of the latter company's employees. Only the one drift is being run at present, but crosscutting is to be undertaken to determine widths.

Phelps Dodge, largest of the Arizona producers, has not considered a wage cut, according to information obtained from the company's New York office. This undoubtedly applies to Old Dominion, which is controlled by the same interests, and to Calumet & Arizona as well. The latter company is to act on a proposal to merge with Phelps Dodge and has nearly always undertaken the same labor policy. (See Market and Financial pages for details of the offer made to C. & A. shareholders.)

Jadot Says U.M.K. Sales Higher Than Output

By special cable to "E.&M.J."

London, July 22.—At the annual meeting of Union Minière du Haut-Katanga, in Brussels, on July 13, Jean Jadot, president of the company, said that operations in the Belgian Congo are being maintained at a profit despite the lowest prices for copper that have ever prevailed. He said that, to date, sales in 1931 have slightly exceeded production, thus cutting into the huge stocks which the company held at the year end, when the balance sheet valued metals on hand at 612,765,006 fr. M. Jadot also confirmed the fact that drilling in the southern area, near the Northern Rhodesia boundary line, had revealed the presence of rich sulphide ore.

. . . . Loangwa Concessions reports the discovery of gold deposits that appear to have possibilities of becoming valuable producers in its concession area in Northern Rhodesia. No copper deposits of importance have yet been found. The company has funds on hand of more than £400,000. Loangwa was formed in 1925 to acquire large concession areas in Northern Rhodesia, which it holds from British South Africa. The total held is more than 135,000 square miles, lying to the south and west of the N'Kana and Rhodesian Congo areas, where important copper deposits have been developed.

. . . . The crosscut from the No. 1 shaft at the N'Changa West property of Rhokana Corporation has entered very rich ore on the 470 level.

■

New Rhodesian Freight Rates

A special freight-rate agreement has been drawn up between Rhodesia Railways, railroad subsidiary of British South Africa, and Rhokana, Mufulira, and Roan Antelope, the principal copper companies operating in Northern Rhodesia. It provides that Rhodesia Railways will carry all the freight for these three companies for the next thirteen years, starting Oct. 1. The rates are reduced from £5 10s. to £4 per long ton on copper; on machinery and equipment materials from £9 to £8; and on Wankie coal, shipped to the mines, from 22s. to 20s.

The significance of this announcement is that it indicates the Northern Rhodesian companies are content to use the East Coast route, via Beira, rather than the new Lobito Bay route, through the Belgian Congo and Portuguese West Africa, although the latter shortens the distance to London by 3,000 miles and by several weeks in time of shipments. It means, therefore, that the Rhodesian mines will either have to build up stocks of copper in England if they desire to take advantage of sudden buying movements. The new rate, even though it is a reduction, still represents a cost of nearly 1c. a pound of copper.

■

Sink Shaft at Swastika Prospect

Lee Gold Mines, Ltd., operating a prospect in Lee Township, north of Swastika, Ont., on the Temiskaming & Northern Ontario Railway, has plans for sinking a prospect shaft to a depth of 125 ft., on a surface showing which to date has yielded encouraging indications in gold mineralization. The vein is said to average $15 per ton in gold across widths of from 3 to 4 ft. and has been traced for a distance of 300 ft. Specimens of mineralized material taken from shallow test pits have yielded spectacular assays.

■

Union Minière Maintained Reserves, Output in 1930

Reserves of copper contained in ore developed at the properties of Union Minière du Haut-Katanga, in southeastern Belgian Congo, were maintained at more than 5,000,000 metric tons in 1930, despite the production of 138,949 metric tons, the highest tonnage in the company's history. (The 1929 output was 136,992 tons.) Systematic development and prospecting of the company's concession area in 1930 led to the opening up of important tonnages of copper ore, according to the annual report, recently released. Production was 2,603,000 metric tons of ore, of which the bulk came from the Luushia, Kambove, and Ruashi mines.

During the year, the Luushia, Kambove, and Chituru mines received the necessary equipment for replacing steam shovels with electric shovels. These three properties are open-pit mines. Completion of the new Chutes Cornet power plant has permitted this electrification program, as previously only the Ruashi mine was electrically equipped. At the Western mines — which were being equipped for production at the time that it was decided to curtail operations, last November—construction of a dam across the Musonoi River has been completed. This dam will permit altering the course of the river so as to make exploitation of the Kolwezi deposit feasible.

The Panda concentrator operated normally throughout the year. It produced 74,000 metric tons of gravity concentrate and 121,000 tons of flotation concentrate, the grades being 32 and 35 per cent copper, respectively. The new Chituru leaching plant produced 21,362 metric tons copper; the Lubumbashi smelter, 57,340 tons; and the Panda smelter, 57,702 tons. In addition, 2,545 tons was recovered from matte and other products shipped to Belgium. Sales of radium were 60 grams, operations being maintained throughout the year at the Chinkolobwe mine.

The Belgian government has decided to honor Jean Jadot, president of the company since its formation in 1906, by changing the names of the towns of Likasi-Panda to "Jadotville." Originally, the intention had been to so name the exploitation center that will eventually be established at the Western group of mines. Likasi, Panda, and Chituru, all of which are within a few miles of each other, not only include one of the company's important mines and its most important metallurgical center, but they also constitute a natural distributing center for the entire Katanga region.

At the Hoboken refinery of the Société Générale Metallurgique de Hoboken, in which Union Minière has a large interest, the capacity of the sulphuric acid unit has been increased sufficiently to permit recovery of the entire sulphur content of the materials treated at the plant. Additions to the copper-refining unit, which will be completed by the end of 1931, will increase capacity to 110,000 metric tons annually.

Cerro de Pasco Closes Furnace in Additional Curtailment

Cerro de Pasco Copper, largest metal producer in Peru, has closed one of the reverberatory furnaces at its Oroya copper smelter. This leaves only one furnace in operation, the blast furnace having been shut down last November, at the time of the disturbances. This additional curtailment is in line with the company's policy of not depleting its ore reserves at a loss. The lead smelter has been closed since November.

The company is continuing development work at its properties, including the Casapalca lead-zinc mine. This unit is no longer in production. At the Yauricocha copper properties, which have not yet been equipped for production, a 600-hp. power plant is being assembled to provide facilities for development. At the Cerro de Pasco mine, which produces copper-silver ore, a new eight-compartment central hoisting shaft is being put down to an eventual depth of 2,000 ft. This shaft, now 1,400 ft. deep, will handle all ores from the mine. Equipment has already been ordered.

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Russia Develops Lead-Zinc Center at Acha-Saya

A geological survey of the Acha-Saya district, in central Siberia, has indicated that the lead-zinc deposits there contain not less than 650,000 metric tons of lead and 450,000 tons of zinc, according to the *Bulletin of Economic Information* of the U.S.S.R. Chamber of Commerce. Since the survey was made, additional reserves are reported to have been developed. A lead smelter is now under construction that will produce 60,000 tons of lead annually. In addition, the local combine will operate the Amalicksky copper deposits, which are to be equipped with a smelter capable of producing 50,000 metric tons annually by 1935.

According to preliminary estimates, the Soviet Union will require 350,000 metric tons of copper in 1933; 475,000 tons in 1934; 585,000 tons in 1935; and 1,200,000 tons in 1938. Production in 1930 is given by the *Bulletin* as only 46,000 tons. According to the Five-Year Plan, output in 1931 should be 150,000 tons. Exploitation of the Kounradsky copper deposits, 18 km. north of Lake Balkhash, is to be undertaken, with capital investment of 450,000,000 roubles (inasmuch as this is $225,000,000, on the basis of the nominal value of the rouble, this figure seems to be in error—Editor). Production by 1933 is to be from 20,000 to 50,000 tons of copper from this property alone, and by 1938 an output of 300,000 tons is anticipated.

■

Resume Work at Coulterville Mine

Development of the Argo Mines property 9 miles east of Coulterville, Calif., has been resumed. C. A. Gillis, of Tuttletown, and J. H. Holbrook, Jr., of San Francisco, have leased the property from W. D. McLean, of Coulterville, the owner. A winze is being put down from the bottom level. Previous development has been through a shallow shaft and a tunnel. Ore occurs in short shoots within a quartz vein, with some associated sulphide. Production in the past has been small.

Assessor Reduces Valuation of Arizona Copper Mines

In the list of assessments of producing metal mines, made public by the State Tax Commission of Arizona, all of the properties show a reduction in their 1931 assessment, compared with 1930, with the exception of Tom Reed Gold, the state's premier gold mine. The total valuation put on seventeen producing mines for 1931 tax purposes was $245,279,727, compared with the valuation of $274,806,761 made in 1930. Most of this valuation, of course, is based on the State's ten large producing copper mines. All of them show substantial reductions, with United Verde and Inspiration receiving the largest cuts and Calumet & Arizona, the smallest, proportionally.

The most valuable single mining property in the State is still adjudged to be the mine and reduction plants of United Verde, which are estimated to be worth $35,000,000 (1930 valuation, $40,252,885). Calumet & Arizona's New Cornelia mine, at Ajo, is next, with a valuation of $33,524,313 (1930, $35,288,750), and Inspiration third, $30,000,000, compared with 1930's $35,172,686. The Bisbee properties of Calumet & Arizona, which ranked fifth in 1930, are ranked fourth this year, ahead of Phelps Dodge's Copper Queen unit. Tom Reed, the only gold mine in the list, is put at $570,250. In 1930 it was not included. Mines that were not included in 1931 but that were listed the previous year are the Night Hawk claim, at Bisbee; the Seventy-Nine Lead property, near Hayden; Arizona Commercial, at Globe; Eagle-Picher Lead, near Nogales; and the Imperial mine, in Pima County.

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Lake Geneva Mill Completed

Towagmac Exploration has completed construction of a new flotation mill, with crushing capacity of 100 tons daily, on the property of Lake Geneva Mines, Ltd., about 35 miles north of Sudbury, Ont., on the Canadian Pacific Railway. A new 55-ft. headframe has been erected and an electric hoist, good for a depth of from 1,000 to 1,200 ft., has been installed. A new diesel-driven electric generator will provide power for the plant. Crushing equipment consists of a Buchanan jaw crusher and a ball mill for fine grinding. The intention is to postpone operation of the mill until prices of lead, zinc, and silver return to normal. It was erected to complete the terms of an option agreement entered into some three years ago.

■

Mining Small Potash Tonnage

Although installation of shaft equipment has not yet been completed at the property, U. S. Potash is mining about 200 tons of crude potash daily from its deposit near Loving, N. M., and trucking it to Carlsbad for shipment. The shaft, a 22x6-ft. unit, has been completed to 1,108 ft. and is being equipped to handle as much as 5,000 tons daily. Several miles of drifting along the deposit has already been completed. Drilling has proved it to be 5 miles long and 3 miles wide. Water encountered in shaft sinking has been cased off, save for a small flow which will be used for operation purposes. A sump and pumps have been installed at 400 ft. for this purpose.

To date the company, which is associated with Borax Consolidated, has spent more than $800,000 and it plans to spend at least $2,500,000 additional in plant and railroad construction before regular production begins. The plant, 14 miles from the mine, will have an initial capacity of 400 tons of pure potassium chloride daily. In addition, the company will produce almost an equal tonnage of manure salts. C. M. Rasor is general manager.

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Corry Formulates Theory of Butte Ore Deposition

In a circular that is included with the annual report of North Butte Mining, operating at Butte, Mont., Paul A. Gow, president of the company, summarizes the results of a study made by Andrew V. Corry, with particular reference to ore deposition east of the Continental Fault. To date, no important orebody has been opened in this area, although North Butte is now conducting an exploration program through its Main Range shaft. The company recently closed its Granite Mountain shaft, which has been put into condition to produce 1,000,000 lb. of copper a month (the grade of ore is about 4 per cent copper). No production is obtained from the Main Range mine. The statement by Mr. Gow follows:

"During the past year an exhaustive study of the Continental Fault has been made by Andrew V. Corry, instructor in geology, Montana School of Mines, and in the general conclusions reached by him other eminent geologists thoroughly familiar with the geology of the Butte district concur. In the opinion of Mr. Corry the vertical displacement on the Continental Fault does not exceed 1,300 ft., and to the east of the fault there has been a horizontal displacement to the right of at least 2,600 ft. and possibly more than 4,000 ft.

"Recent development work in the Main Range mine bears out this conclusion, which means that the Spread Delight vein and other major copper-bearing veins developed west of the fault have been shifted southerly on the east side of the fault and should be cut on the 2,200 level by a relatively short extension of the crosscut which has been driven southeasterly 3,650 ft. from the point where the Spread Delight vein was displaced by the fault. While development work in the Main Range mine east of the Continental Fault has not yet reached our first objective—i.e., the Spread Delight vein—the physical and geological conditions observable throughout present workings are most encouraging and lead to the following conclusions: (a) that the major veins of the Butte district extend to the east beyond the Continental Fault but are displaced by it; (b) that the vertical displacement downward of the area on the west side of the fault does not exceed 1,300 ft.; (c) that there has been a horizontal displacement to the right along the fault of not less than 2,600 ft. and possibly more than 4,000 ft.; (d) that alteration of the country rock by mineralizing agencies has been as intense in the area east of the fault as anywhere else in the Butte district; and (e) that primary mineralization and primary copper ores of grade and character comparable to those of the proven area of Butte exist east of the Continental Fault."

New Orebody Developed in Walker Main Tunnel

At a distance of 3,600 ft. from the portal of the main tunnel of Walker Mining, near Spring Garden, Calif., a new deposit of copper ore has been developed in the hanging wall of the vein. Other important underground developments include the starting of a drift, No. 1,017, on the 1,000 level to cut the North orebody. A pilot drift on the 900 level developed 30 ft. of 4 per cent copper ore in this deposit. This is much higher grade than on the 700 level, where the North orebody is 1,600 ft. long and as wide as 125 ft. in some places. The Central shaft has been sunk to 1,080 ft., where an ore pocket is being cut. The Piute orebody is also being developed on the 1,000 level, a mile further north.

Mine operations are on a basis of two shifts daily, with a total of 400 men employed. The company, which is the largest copper producer in California, is taking advantage of the summer season to raise its tailing dam 8 ft. and construct a bypass for the normal flow of the stream. Three motor trucks and a 1¼-cu.yd. power shovel are used for this work. The sawmill has been started for the purpose of sawing 750,000 ft. of lumber, 60,000 ft. of which will be poles ranging from 12 to 22 in. square.

■

Announce Development of Nevada Brucite Deposit

Drilling on the property of the U. S. Brucite Corporation, in northern Nye County, Nev., has developed 2,000,000 short tons of brucite, according to H. O. Severinghous, of Phoenix, Ariz., organizer of the company. A large tonnage of magnesite has also been indicated. Drilling was to a depth of 200 ft. only. It will be suspended on Aug. 1. The company plans to erect a calcining plant for moisture removal before shipping the material, and also has plans for a railroad. Of the two routes proposed—one to Schurs and the other to Fallon—probably the latter will be chosen, since it will pass through territory where additional freight may be obtained. The distance is 50 miles. A salt deposit, near Sand Springs, has been handicapped because of inadequate transportation. The salt company has offered partly to finance the railroad project.

[Brucite, according to Bayley's "Non-Metallic Mineral Products," occurs in limestone and serpentine, associated with magnesite and hydromagnesite. While easy to carve, it is too soft to stand hard usage. Up to the present its use has been confined to manufacture of ornaments. Possibly the developing corporation has hopes of introducing its use as a refractory. —Editor.]

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Copper Tariff Study Progress

Basic facts for the use of Congress in considering the relative advantages and disadvantages of a duty on copper have been assembled by the mining engineering and accountant members of the staff of the U. S. Tariff Commission. This includes comprehensive data as to costs of production at the principal foreign mines. This will be the first comprehensive survey of copper production costs to be made public.

BRIEF NOTES

Agawam Leases Oxbow. Agawam Mining has leased the Oxbow mine from Atlantis Mining and has put a small force of men at work in the property, which consists of fifteen claims in the Green Valley district, 7 miles south of Payson, Ariz. A narrow ledge, carrying gold-copper ore, occurs in a heavily leached brecciated zone along a fault fracture in granodiorite. The mine has been idle since 1926.

Aramayo Mines Builds Mill. A flotation plant is being installed at the Chocaya property of Aramayo Mines, in Bolivia. Because of the low price of silver, production of silver-tin ore has become unremunerative, and the management is centering operations on tin production. The new mill is expected to improve recovery. Ore reserves at the end of 1930 were 55,114 metric tons of silver-tin ore and 110,206 tons of tin-silver ore. This represents a drop in reserves of the first classification and an increase in the second from the end of 1929. Only ore containing more than 32 oz. of silver per ton is included in the first classification and only ore containing more than 3 per cent tin in the second.

Ashanti Deep Ore Still Good. The monthly report of Ashanti Goldfields, largest producer on the Gold Coast, Africa, shows that the new No. 26 level is as good as were the levels above. No. 7 NE crosscut, the second to cut the high-grade ore, showed a reef 45 ft. wide that averaged 23.7 dwt. in gold per ton. No. 6 crosscut had showed 13 ft. of 19.7 dwt. ore. On No. 25 level, No. 16 NE crosscut showed 10 ft. averaging 50.8 dwt. per ton, and on No. 18 level, in the Cote d'Or reef, crosscut No. 8 SW showed 19 ft. of 38.4 dwt. ore. Both these results are much better than those obtained in adjoining crosscuts. Output in June was about the same as in May, at 14,135 oz.

Benguet Conducting Tests. E. M. Bagley, mill superintendent of Benguet Consolidated, operating in the Baguio district, Philippine Islands, is conducting tests to determine whether or not addition of more agitators to the mill flow sheet will improve extraction. Recovery of gold-silver content of the ore in May was 94 per cent on a tonnage of 9,460. Addition of a third 550-kw. generating unit at the company's Agno power plant is progressing.

Calaska Leases Boytano. Calaska Gold Mining has leased and bonded the Boytano property, southwest of Jamestown, Calif. Present development is supplying a ten-stamp mill on the property.

Coeur d'Alenes Lead Reorganized. At a meeting of the company in Wallace, Idaho, early in the month, control was secured by W. Earl Greenough, vice-president of Atlas Mining. As a result, the entire set of officers was replaced by new men, with James A. Wayne as president and Mr. Greenough as vice-president. The company has been the subject of litigation by Mr. Greenough because of alleged irregularities in connection with its stock issues. Coeur d'Alene Lead is a holding company, its chief interest being in Atlas Mining, in which it has a quarter interest.

Cresson Drives New Crosscut. A new crosscut will be driven on the 700 level of the company's property, in the Cripple Creek district of Colorado, to develop ore opened up in adjoining ground, according to the quarterly report. The company reports a small net profit in the quarter ended June 30. A. E. Carlton, general manager, states that more interest is being shown in Cripple Creek now than in many years.

Dominion Explorers Ships Drill. Diamond drilling has been started at the copper property of Dominion Explorers, on the northeast arm of Great Bear Lake, in Northwest Territories. The surface showing includes a short length of high-grade copper and numerous boulders, estimated to aggregate at least 1,000 short tons, averaging from 5 to 30 per cent copper, according to Thayer Lindsley, president of the company. The drilling will be done by the Sudbury Diamond Drilling Company. To reach Great Bear Lake men and equipment were shipped by rail, boat, and airplane.

Guaranty Mining Formed. Certificates of incorporation have been issued in Missouri to Guaranty Mining & Royalty, of Joplin, Mo., which will operate lead-zinc properties in the Tri-State district. The capitalization is $450,000, of which one-third is in preferred stock. V. V. Kirkpatrick, of Kansas City, and E. Morse, of Joplin, control the company.

Hope Mining Starts Mill. Operation of the new concentrator built by Hope Mining at Clark Fork, Idaho, was started on July 13. The capacity of the plant, built at a cost of $50,000, is estimated at 85 short tons of silver-lead ore daily. Certain adjustments have been made since operation started. The mine, developed through several tunnels, shipped a small tonnage of ore in 1930. It is controlled by local interests.

Midas Lode Runs Mill. Two shifts are being run at the small mill on the Ready Relief and North Hubbard properties, near Julian, San Diego County, Calif. These two gold properties, which were operated in the 'eighties, have been acquired by Midas Lode Mining, which plans further expansion of operations by addition of new equipment. William Paddock is in charge of the mill.

Namaqua Copper Shuts Down. Mining operations have been suspended at the property of Namaqua Copper, operating in Cape Province, Union of South Africa. The company shut down its smelter in July, 1930, but had continued mining and milling a small tonnage during the last year. Production had been about 400 short tons of 23 per cent concentrate monthly, compared with the normal smelter output of 180 tons of blister monthly. The company operated at a loss in 1930.

North Star Unwaters Winze. Installation of electric hoisting and pumping equipment at the winze from the No. 7 level of the North Star Sultan property, near Silverton, Colo., has been undertaken, preparatory to unwatering the winze. The property was recently reopened and has been retimbered to the No. 7 level. A. E. Treveathan is in charge of the property, once a large lead-silver producer. The holdings total 600 acres.

Operator Con. Deepens Shaft. The shaft at the Bender gold property, in the Randsburg district of California, has been deepened from 140 ft. to 200 ft. by Operator Consolidated Mining. Drifting along the vein is under way. The company recently purchased the property.

Park King Crosscuts. On the 500 level of its property, in east Park City, Utah, Park King Mining is crosscutting toward what is believed to be the eastern extension of the Park Utah lead-zinc vein. The crosscut has been in vein matter for 40 ft. At the Park Standard property, which the company is also operating, three headings are being extended in the quartzite formation on fissure veins carrying high values in iron.

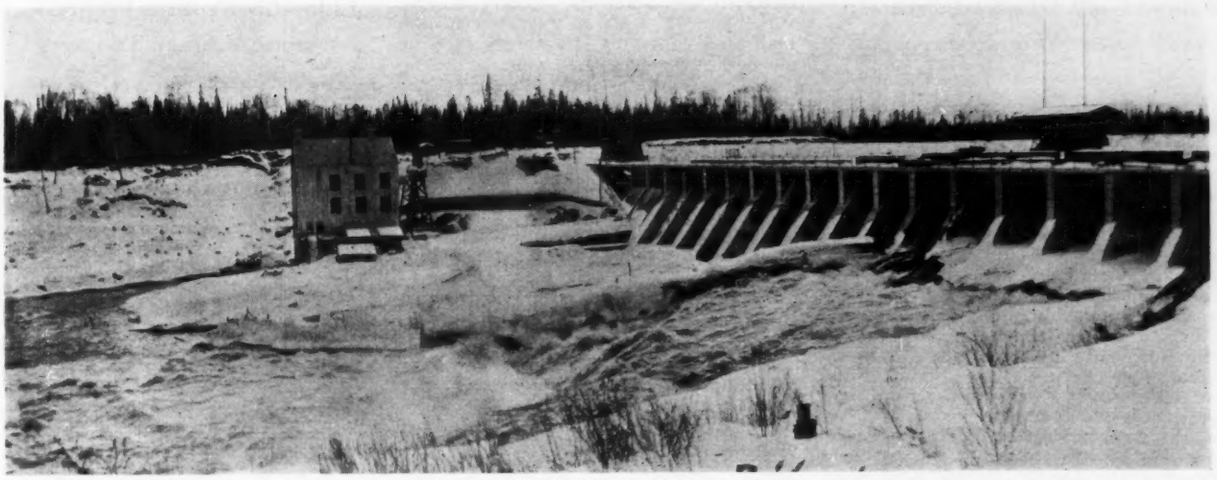
Southern Rhodesia Base Metals Closes. The company, only producer of copper concentrate in Southern Rhodesia, has closed the flotation plant at its Alaska mine because of the failure to develop additional sulphide ore as expected and the continued drop in the price of copper. Up to June 23, when the plant was closed, production from April 1 had been 270 short tons of 63 per cent copper concentrate. Production in recent quarters had been averaging about 450 tons a quarter.

Toburn Hits Ore at 1,210 Ft. A short oreshoot has been developed on the 1,210 level of the Toburn property, at Kirkland Lake, Ont. This property, formerly known as Tough-Oakes-Burnside, is now under option to Premier Gold, Canadian subsidiary of American Smelting & Refining. The work on the 1,210 level shows ore 4 ft. wide, 70 ft. long, and assaying $15 per ton in gold. A diabase dike cuts it off at the east end.

Utah Metal & Tunnel Closes. Operation of the property, in the Bingham district, Utah, has been suspended until market conditions improve, according to W. B. Farmer, managing director. Utah Delaware, subsidiary of Anaconda Copper, operates the mine under contract and ships silver-lead ore over its tramway to the Tooele smelter of International Smelting, another Anaconda subsidiary. Production recently has been curtailed from the normal of about 100 tons of ore daily.

Washington-Idaho Sinks Shaft. Lorian Hudson is sinking the company's shaft, in the Coeur d'Alene district, under contract. The company, which owns property adjoining the Dickens Consolidated claims, plans to drift along the vein for 1,000 ft. after a depth of 350 ft. has been reached. On the 125 level, 400 ft. of drifting has followed a vein 3 ft. wide that contains a narrow lead-zinc shoot. Thomas Murray is manager of the company.

Yellow Aster Being Tested. W. P. Hammon, of San Francisco, is conducting tests to determine the grade of ore and the possible recovery at the Yellow Aster gold property, near Randsburg, Calif. It is now owned by Yellow Aster Mining & Milling, but should tests yield favorable results, Mr. Hammon may acquire the property—for a reported consideration of $750,000—and operate it on a large-scale, low-grade basis. To date the property has produced about $13,000,000 from ore averaging $3.20 a ton in gold.



The Ear Falls power plant, which supplies Howey Gold, in the Red Lake district. Cheap power is one of the most important factors in Howey's low costs—they were $3.20 a ton in June, although the mine is many miles from a railroad.

Proposed Freight-Rate Increase Draws Mine Opposition

The proposal made by the railroads of the country that a uniform increase of 15 per cent be made in all freight rates, so as to prevent further disastrous declines in railroad income, has met with opposition from metal mines, particularly those situated in districts where long rail hauls are the only available transportation means of getting products to market. A. G. Mackenzie, secretary of the Utah chapter of the American Mining Congress, has written to the State Public Utilities Commission strongly condemning any increase. The letter was in response to an inquiry sent out to Utah's major industrial groups.

"Imposition of additional costs on the industry would make it impossible to maintain even the present greatly diminished scale of operations," Mr. Mackenzie wrote. "It would inevitably add many more persons to the State's unemployed."

Lake copper producers are also opposed to the increase, which would mean an addition of 4.5c. per 100 lb. in the cost of delivering copper to Chicago or Detroit, the principal consuming centers of Lake Copper. If it goes into effect, they are likely to ship even more of their copper by water instead of rail, thus defeating the purpose of the proposed increase.

■

Island Copper Cedes Holdings on Isle Royale for Park

Island Copper, which owns 45,000 acres on Isle Royale, in Lake Superior, is willing to turn this tract over to the Isle Royale National Park Commission of Michigan, provided it may be permitted to retain the mineral rights. No objection is expected to this reservation. The island consists of 132,000 acres. Federal legislation has been adopted providing that it shall become a national park as soon as title to all the land is conveyed to the Department of the Interior.

The Isle Royale Commission was created by the 1931 Michigan Legislature to obtain title to the island and turn it over to the Federal government. The State owns 2,300 acres, which it stands ready to deed to the commission. The Federal government has 9,100 acres. No State money is to be used for the acquisition of acreage, but the commission is authorized to accept gifts of land or of money with which to buy land. It can condemn property if it wishes. James MacNaughton, president and general manager of Calumet & Hecla Consolidated Copper, is chairman of the commission.

■

Continue Power Project to Serve Ontario Mines

Despite the slackness in base metals, work on the new 275,000-hp. electrical development program of the Ontario Power Service Corporation, subsidiary of the Abitibi Power & Paper Company, which is primarily designed to provide power for the mining districts, is continuing. Unwatering of the power site at Abitibi Canyon, Ontario, has been completed, the entire flow of the river having been diverted through two tunnels. Grouting and cleaning the dam site is in progress. Half a million barrels of portland cement is on order, and the main dam, according to present plans, will be completed by Feb. 1, 1932. The 200-mile transmission line over which power will be delivered, under the terms of a contract with the Ontario Hydro-Electric Commission to serve the nickel-copper industry of Sudbury district, will be completed by Oct. 1. The entire program, including the installation of the necessary plant for the development of 275,000 hp., will be completed by Oct. 1, 1932.

■

Grand Central Gold Strike

Cecil Fitch, the general manager of Chief Consolidated Mining, reports that an important discovery of gold ore has been made by leasers in the company's Grand Central property, in the south end of the Tintic district of Utah. The strike was made some time ago, and leasers have made several shipments from the deposit, which has improved considerably as the work progresses. A quartz vein, 20 ft. wide, carries $5 to $20 in gold to the ton. The ore comes from the 800 level.

Smuggler Mining Treating Oxidized Gold Ore

Smuggler Mining, near Sheridan, Madison County, Mont., is now operating its mill and putting through nearly 50 tons per day of gold ore assaying around $10 per ton. The ore is oxidized, coming from the west part of the tunnel level. As it contains very little sulphide, the concentrating tables have tenporarily been cut out of the mill flowsheet and amalgamation is showing a high recovery. Amalgam and riffle sets are placed in the main launders to catch the coarse gold before it reaches the plates. The ore is ground in a jaw crusher and ball mill and most of the pulp will go through a 50-mesh screen.

A level 100 ft. below the tunnel is being opened in the mine and shows substantial bodies of sulphide ore, carrying gold and lead. Flotation equipment will soon be added to the mill to take care of the lower-level ores. The company has erected a very complete camp, and all machinery is electrically operated from its own hydro-electric plant, which generates 250 hp. by means of a Pelton wheel. There is more water than needed. The head is 325 ft. The power plant is located only a few hundred feet from the mine. Alex Walker is managing director and Capt. O. F. Brinton, superintendent, of the company.

■

Sample Alder Gulch Gravel

Preliminary to installing a drag-line dredge, California-Alder Gulch, near Virginia City, Madison County, Mont., has increased its crew of sampling prospectors in the main part of Alder Gulch. The samplers work in crews of three. By means of shoveling, panning, and using sluice boxes, the recovery of gold by this method is usually great enough to pay the entire expense of sampling. The gravel south of Virginia City shows 50c. in gold per yard and higher, and the sluice recoveries have shown as high as $5 per yard.

A separate crew is sampling the gravel under the lava cap, which is virgin and shows high gold content. The gold is coarse, with sharp edges, indicating it was not carried as far as the gold in Alder Gulch proper. Frank Zichosch is general manager and Carl J. Trauerman, consulting engineer, of the company.

Wiluna Gold Output Increases; Development Shows Low-Grade

By Special Cable to "E.&M.J."

London, July 21.—Wiluna Gold, newest large producer in Western Australia, reports treatment of 24,510 long tons of ore in June, from which gold valued at £29,881 (or, with exchange premium, £38,500) was recovered. This compares with May output of 22,086 tons of ore and £30,200 in gold, exchange premium included. Working costs in June were £23,728, or 19s. 4d. per ton. In addition, development expense was £4,290, or 3s. 6d. per ton. Preliminary estimates had indicated that Wiluna would have a capacity of 40,000 tons monthly, from which an average recovery of 30s. per ton, or £60,000 a month, was expected. Working costs were put at 19s. a ton, a figure that has evidently been attained already. Failure to operate at capacity is attributed to power-plant troubles.

. . . . Development results on the East lode at depth indicate that the deposit is of lower grade than on the upper levels. At 625 ft., the lode has been cut at 107 ft. and 285 ft. south of the shaft. Although the first crosscut showed 10 ft. averaging 67s. in gold per ton, the second was 12 ft. of low-grade for which the assay was not reported. On the 800 level, the crosscut at 50 ft. south showed 10 ft. of low-grade and at 107 ft. south, 8 ft. of ore averaging only 25s. per ton. On the West lode, drifting along the ore is proceeding northward on the 290 level. The drift shows ore averaging 39s. in gold per ton over the width of the drift, with the full width not exposed.

. . . . Wiluna has helped to swell the gold production of Western Australia. In June, the State produced 47,507 oz.—much the largest output in several years. The best previous month since the beginning of 1930 was 42,097 oz., recovered last December. June, 1930, production was 41,738 oz., and May, 1931, output was 38,255 oz. A strike of woodcutters, however, may hamper the Kalgoorlie mines, most of which depend on wood for fuel. The attempt to lower wages to the new basic scale is said to have caused the strike. As the gold mines have not lowered wages, the woodcutters feel that the old rates should be maintained for them as well.

. . . . Nundydroog Mines, operating in the Kolar district, Mysore, India, has cleared its property of the poisonous gas resulting from the fire at the end of May. Stoping and development have been resumed on a limited scale and an early resumption of milling is expected. In June the company produced only 4,831 long tons of ore, from which 4,581 oz. of gold was recovered. This compares with May production—the normal for recent months—of 12,004 tons, from which 6,947 oz. was recovered.

. . . . C. V. Stephens, chairman of the board of directors of Kramat Pulai, Ltd., operating tin properties in the Kinta district, Perak, Federated Malay States, stated at the meeting of the company that the restriction agreement made at a meeting of producers at The Hague is now functioning. He expects the position of the metal to improve. The company does not anticipate profits from tin under existing conditions. The scheelite market is also in a precarious condition. Unless the price of scheelite (tungsten ore) recovers, operations will be suspended. Kramat Pulai operates a small mill for the treatment of its scheelite deposit. The tin mine is worked by hydraulic methods.

. . . . Lahat Mines, another Malayan producer of tin by hydraulic methods, reports the treatment of 239,110 cu.yd. at a cost of 67.14c. a yard, a decrease of 5.75c., in 1930. The mine is being kept in operation in spite of losses because the subsequent cost of unwatering it would be prohibitive if it were shut down.

. . . . Luiri Gold, only gold producer in Northern Rhodesia, is now treating ore from its Dun Robin mine only, on the recommendation of P. K. Horner, consulting engineer. As a result, the returns for June show an average grade of £2.46 per ton of ore (about $12 a ton), compared with £1.47 in March. The tonnage was lower than recent months, however, being only 1,197 short tons. The mill only ran fifteen days.

. . . . Russia is buying daily $500,000 worth of British machinery, including mining machinery, according to statements in the House of Commons during debate on the government's granting of $12,500,000 credit to Russian industry. As a result of the support expressed even by Conservative members of the House of Commons, granting of the credit seems likely. Scandinavian countries have recently taken similar steps.

■

Gold Coast Mine Reserves Up

Taquah & Abosso, second largest gold producer on the Gold Coast, Africa, reports an increase of 49,718 tons in ore reserves at the end of the fiscal year, March 31, 1931. The total reserve is now 284,290 tons, averaging 33s. 1d. per ton in gold. In addition, 42,330 tons of lower-grade material are known that can probably be treated profitably with the present lowered costs. During the year, the average per ton, including development, was 25s. 2.5d., a drop of 3s. 10.7d. Production during the fiscal year was 118,589 tons, compared with 100,790 tons in the previous year. Recovery was £191,022, compared with £168,558.

The most important feature of the company's operations was the development of ore beyond the faulted zone. Nearly all the levels have now passed through this zone. On No. 13 level, ore averaging 36s. per ton over 56 in. has been found. Each of the succeeding levels shows comparable results, with the No. 19 level, which has just entered the ore, opening 42 in. that average 40s. 6d. per ton.

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Equip Claim in Fireball Area

Timbers for headframe, an air compressor, and gasoline engines have been taken to the new gold camp of Fireball, Nev., where a high-grade strike was made early in July. Ex-Governor Scrugham of Nevada has a lease on the property that is being equipped for development and, in addition, an area of about 100 acres ½ mile north of the strike, made on the Patty claim. Fireball Mines, Inc., has started sinking a shaft near the cross-fracture in the Patty claim where the strike was made. A small gasoline hoist has been installed, and the owners plan to drive a crosscut to the vein at intervals of 25 ft. in depth.

Eldorado Reports Progress at Arctic Radium Property

Charles LaBine, president of Eldorado Gold Mines, has prepared a progress report on the properties of the company in Northwest Territories, Canada, where a deposit of radium-bearing pitchblende is being developed. A memorandum of the Canadian Department of Mines, issued in March, states that hand cobbing and sorting of the ore should prove sufficient to produce a high-grade pitchblende product suitable for chemical treatment for the recovery of the contained radium. Mr. LaBine's letter follows:

"On Sept. 25, 1930, we advised our shareholders of the fact that we had acquired promising mining claims in the Great Bear district, Northwest Territories, and, in view of this discovery, advised our shareholders at that time not to sell their stock, feeling, as we did, our obligation to them as original subscribers to our capital.

"At the annual meeting on April 14 last we informed our shareholders of the developments up to date in detail, pointing out that the government analysis of samples of our pitchblende ores as submitted showed radium value of about $7,225 to the ton.

"Our general manager, with eight men, traveled by plane to the properties in the latter part of February, with a view to further developing the extent of these rich orebodies. We have now to inform you that, from reports received from Gilbert LaBine, our general manager, the results so far have greatly exceeded our most optimistic hopes, owing to the fact that we have proved rich radium-bearing ore over greater width and length than we had anticipated.

"In addition, we have discovered very rich silver ore, with evidence of large tonnage. Your general manager has also staked an additional group of fifteen claims showing silver in many places over a distance of 2 miles. These claims have been staked 6 miles south of our original radium-bearing deposits."

■

Revival Seen at Gilbert, Nev.

Increased interest in gold mining is resulting in a revival of activity at the old camp of Gilbert, Nev. Esmeralda Gold has taken over the Green Gold and Esmeralda properties. At the Green Gold shaft, sinking is now below the 100 level, with high-grade ore still showing. The shaft entered ore at 50 ft. Two carloads of ore broken in sinking have already been shipped and a third is being prepared.

Six leases are being worked on the Esmeralda claim, but only one of them is in ore to date—the Bettles lease, which is down about 50 ft. None of the other lessees is below 35 ft. as yet. Two carloads of high-grade ore have been shipped by Gilbert Mammoth Gold, which operates the property of Gilbert Mammoth Last Hope under lease.

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Mount Isa Reports Output. During June, the first full month of operation, Mount Isa, the new Queensland lead producer, reports treating a total of 26,630 long tons of ore. More than 2,000 tons of sinter were in stock at the end of the month. Lead bullion production was 783 long tons, of which 453 tons was shipped through Townsville. Output will be gradually worked up to 6,000 tons a month, which will make the company the largest lead producer in Australia.

MARKET AND FINANCIAL NEWS

Release Merger Terms for Phelps Dodge and C. & A.

Directors of Phelps Dodge and Calumet & Arizona, leading copper producers of the Southwest, have made public the terms of the proposed merger between the two companies. The terms call for exchange of 3¼ shares of Phelps Dodge for each share of C. & A. outstanding. In addition, C. & A. shareholders would receive $2.50 a share. By this arrangement, Phelps Dodge capitalization would have to be increased to more than 5,500,000 shares, as it already has 2,822,912 shares outstanding. C. & A.'s 837,540 shares would be convertible into 2,722,005 shares of Phelps Dodge. The entire transaction, of course, is subject to the approval of the shareholders.

Phelps Dodge, in 1930, produced 141,662,995 lb. of copper from its own mines, in addition to gold, silver, lead, and manganese. Its smelters treated a sizable tonnage of custom ore, and the refineries of Nichols Copper, a subsidiary, treated a total of 425,000,000 lb. of copper. The company owns mines at Bisbee and Morenci, Ariz.; Tyrone, N. M.; and Nacozari, Sonora, Mexico. The Tyrone property is now inactive, but the other mines are operating on a reduced tonnage. All three are equipped with concentrators. The company's smelter at Douglas, Ariz., treats ore from Bisbee and Nacozari, and the smelter at Clifton, Ariz., treats Morenci concentrate. Ore reserves at the Bisbee and Nacozari mines have been about maintained in recent years. At Morenci, the Humboldt orebody, which at present supplies most of the material for the mill, is nearing exhaustion. A huge new orebody has been developed in the Clay deposit, containing 250,000,000 tons of 1.1 per cent material. Equipment of this deposit for production has been under consideration. It would probably cost about $30,000,000. Phelps Dodge as a whole is considered a high-cost producer of copper. The company has not issued cost figures in recent years.

Phelps Dodge has interests in copper refining and manufacture. Through the Nichols Copper unit, a subsidiary, it owns refining plants at El Paso, Tex., and Laurel Hill, N. Y. (where a custom smelter is also operated), and has a substantial interest in the new Canadian Copper Refiners' plant, at Montreal East, Que. The corporation also owns National Electric Products, a large manufacturer of copper, steel, rubber, and textile products for electrical purposes.

Calumet & Arizona, in contrast with Phelps Dodge, has not gone outside the field of copper mining and smelting. It owns three mining properties—the New Cornelia unit, at Ajo, Ariz.; the Bisbee-Warren group, original holdings when the company was formed, in the Bisbee district; and the Eighty-Five mine, in the Lordsburg district, New Mexico. New Cornelia is a large low-grade open-pit property, which normally mines carbonate ores for treatment in a leaching plant and sulphide ores for treatment in a large concentrator. The leaching unit is now closed. Bisbee and Eighty-Five mine ores and New Cornelia concentrate are all smelted in the smelter at Douglas, Ariz. Although the company's production is smaller than that of Phelps Dodge—only 88,839,719 lb. of copper in 1930—it is lower cost. C. & A. has ample reserves at all its properties.

The merger terms are considered, on the whole, favorable to Calumet & Arizona. It receives almost an equal equity in the merged company, even though its production is smaller and its interests are less extensive. According to press reports in New York, one of the reasons for the eagerness of Phelps Dodge officials to bring the negotiations to a successful consummation was that, in view of present economic conditions, they would prefer not to proceed with equipment of the Clay orebody—a step which would be necessary to maintain the company's production if C. & A.'s ore reserves were not obtained. By the merger, additions to equipment are unnecessary, as C. & A. has ample excess capacity, particularly at Ajo, where the leaching plant and mill combined can handle at least 22,500 short tons of ore daily, compared with a present daily rate of about 6,000 tons. The lower cost of the C. & A. units was undoubtedly a factor in determining the terms, as low copper prices might well mean operating losses for Phelps Dodge alone. At its Bisbee mines, Calumet & Arizona has developed in its Campbell orebody, still almost untouched, what is probably the largest and highest-grade orebody ever found in the Bisbee district.

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North Butte Mining Loss

North Butte Mining, small copper producer, operating in Montana, reports a loss of $11,614 in 1930 from operation of its Granite Mountain mine. This was after depreciation and miscellaneous charges. In addition, the company spent $336,100 on its development account, including $249,281 at the Main Range mine. Income from metals mined in 1930 was $390,547. This represented an output of 65,922 short tons of ore, containing 5,539,783 lb. of copper, 205,681 oz. of silver, and 341 oz. of gold. In 1929, the company reported a loss of $59,108 on production of 5,464,573 lb. of copper from 88,350 tons of ore.

■

ALASKA JUNEAU in June, 1931, mined and trammed to mill 342,440 tons, from which the estimated operating revenue was $325,500, or 95.06c. per ton; operating expenditures were $173,500, or 50.66c. per ton; and operating profit was $152,000, or 44.4c. per ton. Interest on current funds was $6,800 and other expenditures totaled $4,000, leaving to surplus $154,800 for the month.

Primary Copper Production by United States Mines

(American Bureau of Metal Statistics)

In Short Tons

	1929		1930		1931	
	Monthly Production	Daily Rate	Monthly Production	Daily Rate	Monthly Production	Daily Rate
January	86,325	2,785	67,838	2,188	48,059	1,550
February	84,735	3,026	59,196	2,114	47,504	1,697
March	93,698	3,023	61,216	1,975	48,702	1,571
April	94,902	3,163	60,450	2,015	46,452	1,548
May	93,392	3,013	60,238	1,943	45,580	1,470
June	82,354	2,745	56,743	1,891	44,647	1,488
July	79,229	2,556	54,249	1,750	.....	.....
August	78,885	2,545	56,136	1,811	.....	.....
September	79,402	2,647	56,584	1,886	.....	.....
October	82,575	2,664	55,954	1,805	.....	.....
November	75,934	2,531	53,141	1,771	.....	.....
December	74,772	2,412	48,726	1,572	.....	.....
Total	1,006,203	2,757	690,471	1,892	280,944	1,552
Monthly average	83,850		57,539		46,824	

Unexpected Decline in Copper Consumption Points to Further Cut in Output

E. H. Robie
Associate Editor

With the increase in total stocks of copper to the highest level in history, and with a corresponding drop in the price to an all-time low, the copper interests of the world are again giving real thought to curtailment. Last November, at a conference, representatives of 90 per cent of the world's copper production decided to curtail production by about 20,000 tons monthly, or 15 per cent, to bring output in line with consumption. The agreement was apparently fully lived up to, for the October world production was 152,000 tons, and in June it had dwindled to 127,000 tons. But the producers had not counted on a continued decline in consumption in the first half of 1931, a decline that has nullified the effort made by them last fall to prevent a continued increase in stocks. So, recently, they had another meeting to discuss the situation. This did not end so favorably, no agreement on curtailment being reached. All agreed that too much copper was being produced, but some of those whose operating costs are not above present prices were unwilling to curtail further while the high-cost companies continued to produce. So the matter of reducing or suspending operations is again a problem for individual solution.

The situation is not unlike that obtaining just ten years ago. At that time, stocks had, as now, grown to unwieldy proportions; not so much refined copper was available, but more blister and copper was in process and in the form of scrap. The price was between 12 and 13c., but costs were much higher then than they are now, so that the margin of profit—or loss—per pound of copper was not much different. A drastic remedy was needed to right the situation, so many of the important producers decided to close down entirely, maintaining only skeleton organizations to carry on a limited amount of development and to act as a nucleus operating force when the time seemed ripe for reopening. The important companies that ceased operations in the spring of 1921 were United Verde, United Verde Extension, Calumet & Arizona, Phelps Dodge, Old Dominion, Inspiration, Ray, and Consolidated Arizona, all operating in Arizona; Chino, Nevada Con., Utah, Anaconda, North Butte, and Calumet & Hecla. The following companies continued operations: Kennecott, Mother Lode, Davis Daly, East Butte; Quincy, Copper Range, and Mohawk, in Michigan; New Cornelia (in part); and the Lewisohn properties—Miami and Tennessee Copper. In fact, Copper Range, Mohawk, and Mother Lode actually produced more copper in 1921 than in 1920. Among foreign producers of importance, those closing down included Britannia, Greene Cananea, and Mount Morgan. Chile and Braden cut production in 1921 to half that for 1920; but Granby, Cerro de Pasco, Katanga, and Mount Lyell increased output.

These names are given to show how the various companies felt at that time, and not as an indication of what their present policy might be, for conditions have changed greatly so far as some individual companies are concerned. It will be noted, however, that all the properties in the Jackling porphyry group closed down in 1921, and rumors have recently been heard that they are again seriously considering such a step.

In general, the companies that closed down remained so for about a year, or until the spring of 1922. The price dropped a little after the cessation of operations, to as low as 11⅝c., delivered, in August, 1921, but it subsequently improved, and by April, 1922, was again around 12¾c.—about the same level as when the suspension was ordered. When a decision was made to resume operations, conditions were on the mend, even if not satisfactory. Stocks were declining, but still well above requirements. Resumption of production did not keep pace with consumption, and early in 1923 the price rose to 17½c., which, of course, was so high that production was unduly stimulated, with the inevitable reaction later in the year.

This brief summary of what happened the last time conditions were comparable to what they are now is offered merely to guide thought in the present emergency. Unless a rapid improvement in the world consumption of copper takes place in the latter half of 1931, a radical curtailment of copper production is in order. Apparently this must be largely an individual matter. If enough individuals do not voluntarily curtail by an important amount, then a complete cessation of operations by some of the higher-cost producers must be expected. Such a cessation of operations for at least a year would be indicated by the present conditions in the industry.

To shut down a mining operation completely in these times is a serious matter from the social standpoint, for employees cannot find other jobs. And from the operating standpoint an expense is always incurred at a mining property that is being maintained ready for operation, though not producing. The property must be guarded, the mine pumps kept in operation, and the ravages of the climate on idle machinery and equipment prevented so far as possible. A limited amount of mine development and research is also conducted at most properties. And when the time for reopening comes, shafts have to be restored, fallen rock removed, skipways and timbering repaired, a staff reassembled and in part trained, and hundreds of other items of expense incurred that cannot be charged against current production. So a company may well hesitate to cease producing, even though it is producing at a loss. But with present conditions, the high-cost producer can hardly be hopeful of a sufficient improvement in the price in the immediate future to make his operations profitable.

If forced to close down completely, those companies in position to do so can temper the blow to their employees to some extent by allowing free rent of company houses, or at least deferring charges for rent until the employee is again earning money. Or, instead of producing at a loss, they might cease adding to the stocks of copper in the world and lend the money thus saved to old employees in actual need of subsistence—a dole to be repaid when conditions improve.

Although present conditions are what copper producers must face, the attempt to improve those conditions in a positive rather than a negative way must be whole-hearted. It is not enough to curb production: equal thought must be given to stimulating consumption. With copper at the lowest price in history, what an argument there is for using it for almost every purpose where its cost has heretofore been a serious obstacle. Railroad electrification alone offers vast possibilities, and the fact must be driven home to railroad executives that the immense developments in Africa do not mean that copper is going to remain on the bargain table indefinitely. With money cheap and the price of essential commodities at the pre-war level or less, what better time could there be for adding to capital values? The public utility companies are taking advantage of current conditions, as is indicated by the fact that last year—the first full year of the depression—more copper was used for light and power lines (transmission and distribution wire and busbars) than in any other year in history. Last year also set a new record in the consumption of copper for wire cloth and for heat radiators, and the shipbuilding industry used more copper than in any year since 1923. These facts suggest that promising new as well as old fields for increasing copper consumption should now be cultivated aggressively and persistently.

The copper situation is serious. It must be attacked from both ends, and the sooner radical steps are taken for its improvement, the shorter will be the period of distress.

United States Lead Stocks Down 2,672 Tons

Stocks of lead in the United States at the end of June amounted to 139,698 tons, a reduction of 2,672 tons compared with the figures for the preceding month. Though the decline in stocks was not large, the statistics were significant in that the reduction is the first reported since April, 1930, when the quantity on hand was down to 42,015 tons. The peak in stocks was reached in May of the current year—142,370 tons.

Shipments during June were larger than in May, totaling 37,054 tons, an increase of 2,973 tons. Cables, tin foil, sundries, and unclassified consumers of lead (chiefly lead pigments), absorbed larger quantities of the metal than in May.

Production figures reflected further curtailment in output. Production from domestic ore during June fell to 30,708 tons, against 39,519 tons in May, 35,498 tons in April, and 50,721 tons in June, 1930.

Domestic lead statistics, as compiled by the American Bureau of Metal Statistics, follow:

United States Lead Statistics

In Short Tons

Production:	May	June
From domestic ore	39,519	30,708
Secondary and foreign	3,598	3,683
Totals	43,117	34,391
Stock at beginning (a)	133,457	142,370
Total supply	176,574	176,761
Stock at end (a)	142,370	139,698
Shipments by difference	34,204	37,063
Shipments reported	34,081	37,054

(a) Domestic only.

Industrial classification of domestic lead shipments for April, May, and June, in tons, follows:

	April	May	June
Cable	9,175	8,433	8,877
Ammunition	3,722	1,609	1,328
Tin foil	1,798	510	1,233
Batteries	2,684	3,762	3,467
Brass-making	263	176	235
Sundries	2,119	1,817	2,677
Jobbers	229	228	346
Unclassified (a)	15,344	17,546	18,891
Totals	35,324	34,081	37,054

(a) Of the shipments reported as unclassified about one-third moves normally into white lead and about 30 per cent into red lead and litharge, as averages, but it is impossible to make a monthly segregation of the shipments according to these destinations. Other important manufactures are sheet and pipe, solder, and babbitt metal.

■

Nitrate Cartel Disbands

Negotiations looking to the extension of the nitrate cartel, in progress for two months, have failed both as regards world control and agreement on European distribution, according to an announcement made in Lucerne on July 16. Chile will resume open market sales as before the first international agreement two years ago.

According to an official in Chilean Nitrate and Lautato Nitrate, representing the natural output, the collapse of the plan is due to Germany's action in placing a duty of 120 marks a ton on imports. Chilean representatives claim that the international cartel has been highly disadvantageous for the natural product. Chile has demanded an equalization of prices with the synthetic product and a larger portion of the European business.

An attempt to form a purely European nitrate cartel also failed.

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Sharp Drop in Canadian Silver Production

Silver statistics for June reveal a sharp decline in Canadian production, the output for that country amounting to 731,000 oz., against 1,836,000 oz. in the month of May. The reduction in output was probably caused by the suspension of operations in the Cobalt district of Ontario and curtailment at Portland Canal, British Columbia.

Production in the United States during June was at about the same rate as in the preceding month. According to the American Bureau of Metal Statistics, June production in this country totaled 2,733,000 oz., against 2,762,000 oz. in May, and 3,969,000 oz. in June of last year.

Peru produced 1,157,000 oz. of silver in June, against 1,389,000 oz. in May, and 1,527,000 oz. in June, 1930.

Australia produced 558,000 oz. in June, against 638,000 oz. in the month previous.

Production figures for Mexico for the months of May and June have not yet been released.

Available statistics for April, May, and June, in thousands of ounces, follow:

	April	May	June
United States	2,831	2,762	2,733
Canada	1,139	1,836	731
Mexico	9,567	(a)	(a)
Peru	1,215	1,389	1,157
Australia	683	638	558
Burma	530	470	(a)

(a) Not yet available.

The countries listed produced about 87 per cent of the world's production of silver in 1930.

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Quarterly Reports

HOLLINGER CONSOLIDATED, operating a gold property near Timmins, Ont., reports a profit of $520,523 in the second quarter of 1931, compared with $982,946 in the first quarter. Production was $2,249,345 in the second quarter, or almost $400,000 lower than in the first. The drop was the result of handling lower grade ore. For the first six months of 1931, profit, after all expenses but before depreciation, was $1,503,469, compared with $4,083,881 for the entire year 1930.

MAGMA COOPER, copper producer of Arizona, reports a net profit of $76,359, before Federal taxes but after depreciation, in the second quarter of 1931. Production cost on 7,717,907 lb. of copper was 8.7c. a pound. The mine has been closed till Oct. 1. In the first quarter, the profit was $111,425 and the cost was 8.8c. a pound.

DOME MINES, gold producer of Ontario, reports a net profit, after taxes but before depreciation, of $434,343 in the quarter ended June 30, compared with $448,148 in the preceding quarter. Production was $923,341, compared with $842,383. For the six months, profit was $882,491, compared with $48,923 in 1930 (when the mill was idle because of fire), and $1,208,895 in 1929.

MCINTYRE-PORCUPINE MINES, gold producer of Ontario, reports net profits, before depreciation, of $461,471 in the quarter ended June 30, 1931. This compares with $484,035 in the same quarter of 1930. Production for the quarter was $1,124,671, compared with $1,148,866 in 1930.

■

World Zinc Production Down 22.8 Per Cent

Zinc production of the world during the first six months of 1931 amounted to 625,587 tons, against 812,815 tons in the same period last year, a reduction of 22.8 per cent. In the first half of the current year the United States produced 172,720 tons and the rest of the world 452,867 tons, compared with 277,206 and 535,609 tons, respectively, in the same time last year.

Zinc production for the January-June period, 1930 and 1931, in short tons, follows:

	Jan.-June 1930	Jan.-June 1931
United States	277,206	172,720
Mexico	18,202	20,666
Canada	57,212	66,513
Belgium (a)	102,350	79,512
France	53,752	38,001
Germany	58,840	27,332
Great Britain	28,888	13,593
Italy	9,286	9,531
Netherlands	13,364	11,811
Poland (a)	99,679	89,601
Spain	5,816	5,674
Australia	30,843	30,237
Rhodesia	10,627	7,696
Elsewhere (b)	46,750	52,700
Totals	812,815	625,587

Zinc production during April, May, and June, by countries, in tons, according to the American Bureau of Metal Statistics, follows:

	April	May	June
United States	29,137	25,688	23,483
Mexico	3,384	3,630	3,184
Canada	11,280	12,049	11,226
Belgium	(c)	(c)	(c)
France	6,105	6,004	5,786
Germany	3,944	3,354	3,015
Great Britain	2,192	1,924	1,282
Italy	1,433	1,409	1,436
Netherlands	1,924	(d) 2,000	(d) 2,000
Poland (a)	14,154	13,887	13,417
Spain	947	972	936
Australia	5,006	5,339	4,973
Rhodesia	1,131	1,137	1,148
Elsewhere (b)	9,000	9,000	8,900
Totals	89,637	86,393	80,786

(a) Includes zinc dust. (b) Partly estimated. Includes Norway, Yugoslavia, Czechoslovakia, Russia, Indo-China, and Japan. (c) Not reported by months. Output of Belgium for first six months of 1931 was 79,512 tons. (d) Estimated.

Refined Copper Stocks Increased in June

The copper statistics for June revealed a gain of 14,807 tons in stocks of refined metal in the hands of North and South American producers, the total on the last day of the month amounting to 413,474 tons. Stocks in Great Britain increased 1,978 tons, and Havre reported a gain of 1,028 tons. Blister stocks again registered a decline, according to the American Bureau of Metal Statistics. Combined foreign and domestic shipments for June were 83,468 tons, against 71,949 tons in May, and 116,705 tons in June, 1930.

Summary of Copper Statistics

In Tons of 2,000 Pounds

Production:	May	June
Mines, United States	45,580	44,647
Blister, North America (a)	66,812	65,110
Blister, South America (a)	24,812	24,785
Refined, No. & So. America	102,695	98,275
World, blister basis	130,486	.....
Stocks (end of month):		
No. and So. America:		
Blister (b)	190,578	187,353
Refined	398,667	413,474
Totals	589,245	600,827
Great Britain (c)		
Refined	15,085	17,063
Other forms	1,452	1,382
Totals	16,537	18,445
Havre	11,045	12,073

(a) Includes direct-cathode copper. (b) Includes in process. (c) Official warehouses only.

U. S. Mine Production

	May	June
Porphyry mines	18,836	18,312
Lake mines	4,727	5,422
Vein mines	19,408	18,313
Custom ores	2,609	(a) 2,600
Total crude production	45,580	44,647
Daily rate	1,470	1,488

(a) Partly estimated.

Smelter Production

	May	June
United States	53,734	51,652
Canada	9,000	9,591
Mexico	4,078	3,867
Totals	66,812	65,110

Shipments

North and South America

	Export	Domestic	Total
1926	525,861	902,174	1,428,035
1927	641,865	824,844	1,466,709
1928	674,221	983,460	1,657,681
1929	586,594	1,119,409	1,706,003
1930			
January	30,358	69,932	100,290
February	29,597	61,879	91,476
March	30,523	73,644	104,167
April	29,196	50,017	79,213
May	49,115	75,760	124,875
June	44,818	71,887	116,705
July	42,466	75,436	117,902
August	38,319	56,810	95,129
September	37,873	65,169	103,042
October	38,246	75,703	113,949
November	45,051	62,693	107,744
December	39,169	69,854	109,023
Totals	454,731	808,784	1,263,515
1931			
January	45,597	60,209	105,806
February	39,415	60,636	100,051
March	36,797	74,685	111,482
April	32,218	54,567	86,785
May	26,684	45,265	71,949
June	33,251	50,217	83,468

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CASTLE-TRETHEWEY MINES, Ontario silver producer, reports a net loss in the year ended March 31, 1931, of $20,706, before depreciation, compared with a profit of $78,407 in the preceding year. The company produced silver and cobalt valued at $191,729, which included 611,865 oz. of silver. Cobalt output was 94,173 lb. The property has now been closed. The company has current assets of $918,969 and current liabilities of $16,725.

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Purchases of Platinum Decreased in 1930

The platinum refiners of the United States purchased 797 oz. of crude placer platinum of domestic origin and 44,765 oz. of foreign crude platinum in 1930, according to the U. S. Bureau of Mines. In 1929 the refiners purchased 516 oz. of domestic crude platinum and 51,618 oz. of foreign crude platinum. Domestic material purchased in 1930 included 513 oz. from Alaska, 236 oz. from California, 10 oz. from Oregon, and 38 oz. from unspecified sources. Purchases of foreign crude platinum in 1930 included 547 oz. from Australia, 6 oz. from Canada, 40,520 oz. from Colombia, 2 oz. from Russia, and 3,690 oz. from South Africa.

Refined platinum metals recovered in 1930 from crude platinum, from ore and concentrates, and from gold and copper refining amounted to 43,502 oz., of which 9,308 oz. was reported to have come from domestic materials.

Platinum metals imported for consumption in the United States, 1929-1930, by metals, in troy ounces:

Metal	1929	1930
Platinum:		
Ores of platinum metals (platinum content)	564	.....
Grains, nuggets, sponge, or scrap	74,063	81,229
Ingots, bars, sheets or plates, not less than ¼ in. thick	40,594	24,926
Totals	115,221	106,155
Manufactures of, except jewelry	2	25
Iridium	4,470	4,196
Osmiridium	6,863	5,654
Osmium	1,124	1,100
Palladium	24,364	18,506
Rhodium	2,073	2,291
Ruthenium	958	1,319
Totals	155,075	139,246

Production of Cadmium in U. S. Increased in 1930

The production of metallic cadmium in the United States in 1930 amounted to 2,777,762 lb., valued at $1,777,768, according to the U. S. Bureau of Mines. This is the largest annual production on record and is 12 per cent higher than the output of 2,481,427 lb. in 1929, the previous record, which was 32 per cent higher than production in 1928. Sales of cadmium by domestic producers in 1930, however, amounted to only 1,664,644 lb., 29 per cent lower than the sales reported for 1929.

The average value reported by producers in 1930 was 64 cents a pound as compared with 81 cents a pound in 1929. Imports of cadmium dropped from 214,307 lb., valued at $184,527, in 1929 to 40,105 lb., valued at $27,915, in 1930. There were eight producers of metallic cadmium in 1930, American Smelting & Refining Company, Denver, Colo.; Anaconda Copper Mining Company, Great Falls, Mont.; Evans-Wallower Zinc Company, East St. Lounis, Ill.; Harshaw Chemical Company and Grasselli Chemical Company, Cleveland, Ohio; New Jersey Zinc Company, Palmerton, Pa.; Sullivan Mining Company, Kellogg, Idaho; and U. S. Smelting, Refining & Mining Company, Midvale, Utah.

■

Zinc Cartel Renewed

The zinc cartel, representing producers in all countries except the United States, was renewed at a meeting held in Brussels, July 11. An agreement was reached to curtail production and regulate the sale of surplus stocks of zinc. Reduction in foreign production is to be drastic, amounting to about 55 per cent of the quotas agreed to before the cartel disbanded at the end of 1929.

World Production of Copper

(American Bureau of Metal Statistics)

World production of copper during June was at the daily rate of 4,224 tons, against 4,209 tons in May, and 5,023 tons in June of last year. The daily rate for the first six months of the current year was 4,316 tons, against a daily rate of 4,950 tons for the whole of 1930. Copper production of the world for the first half of the current year, based on fine copper content of blister, as reported by smelters, without segregation according to countries of origin, in short tons, follows:

	January	February	March	April	May	June
United States	53,249	55,229	57,922	52,085	53,734	51,652
Mexico	4,489	4,149	4,094	3,799	4,078	3,867
Canada	8,852	9,408	9,228	9,625	9,000	9,591
Chile and Peru	24,064	24,124	24,551	24,613	24,812	24,785
Japan	7,003	7,190	7,041	7,334	7,230	6,970
Australia	300	1,218	1,946	435	1,873	1,296
Germany	5,353	5,067	6,276	5,886	4,459	5,161
Other Europe (a)	12,500	11,300	12,600	12,300	12,300	11,800
Elsewhere (b)	13,400	11,000	13,300	12,800	13,000	11,600
World's total	129,390	128,685	136,958	128,877	130,486	126,722

(a) Partly estimated. Includes production of blister copper in countries other than Germany, whereof Spain, Russia, Yugoslavia, and Great Britain are the more important. (b) Chiefly Africa; partly estimated

The irregularity of the monthly totals for Australia is ascribable to the intermittent operation of two of the smelters there.

Copper Again Sells at 7.75c., Delivered, in Quiet Market—Lead Steady

New York, July 23, 1931.—Uncertainty over the outcome of the German financial crisis had a depressing influence on the market for non-ferrous metals. Business was extremely quiet in the last two weeks, and prices named for copper, tin, and silver were somewhat lower. Lead and zinc, however, ruled steady on the more favorable statistical outlook for both of these metals. Consumption of major metals held at about the same level as in June. Announcement of the renewal of the European zinc cartel removed some of the selling pressure in this item in foreign markets. In minor metals, lower prices obtained for both antimony and quicksilver. Platinum was quiet, but prices were well maintained, both here and abroad.

Copper Unsettled

The muddled European situation, together with the rather poor June statistics, held business in copper down to a low level, and prices eased off early in the period to the basis of 8c. per pound, delivered Connecticut. The export price was reduced to this basis on June 11. The reduction in the export quotation amounted to 52½ points, establishing the c.i.f. price at 8.25c. In narrowing the differential between the domestic and foreign quotation, Copper Exporters, Inc., has now passed along the full reduction in freights announced a short time ago. Foreign sales for the month to date have been disappointing, totaling 14,200 long tons.

Though large producers adhered to the 8c. level, custom smelters were sellers at 7¾c., equaling the all-time low established in June of this year. Most of the copper sold during the period was for last-quarter delivery, demand for near-by material at current prices being at a standstill.

Curtailment plans announced by Cerro de Pasco and Magma were looked on with favor, and producers hope that the movement will extend to the point where the monthly increases in stocks will be arrested.

Lead Holds at 4.40c.

Though trading in lead was of modest proportions, the undertone was steady in all directions. Prices remained unchanged at 4.40c., New York, the contract basis of the American Smelting & Refining Company, and at 4.225c., St. Louis. Most of the demand was for August shipment lead, with corroders the principal buyers. From present indications, July shipments to consumers promise to hold at about the same level as in June. Production is expected to decline further, pointing to another reduction in stocks. The June statistics were encouraging, showing the first decline in stocks in more than a year.

Zinc Unchanged

Prime Western zinc prices ranged from 3.85c. to 4c., St. Louis basis, with most of the moderate tonnage traded in sold at 3.90c. Producers feel that the zinc situation is pretty well in hand, both here and abroad. The July statistics for the United States are expected to show up even more favorably than those for June.

Tin Irregular

Trading in tin was quiet, with prices somewhat easier. The unsettlement in the market was occasioned largely by the developments in the European political situation. Statistics for July are expected to show a slight decrease in the visible supply, notwithstanding the quiet prevailing.

Silver Below 28c.

Disappointment over the slow progress made in the negotiations attending the German financial crisis caused prices for silver to ease off again, the market settling at 27¾c. per ounce, which compares with the recent high of 29¾c.

Other Metals

Quotations cover wholesale lots, f.o.b. New York, unless otherwise specified. London prices are according to latest mail advices.

ALUMINUM—Per lb., delivered, Alcoa commercial and mill ingot, 99 and 98 per cent, 23.30c.; Alcoa No. 12 alloy, 22c.; metallurgical ingot, 94 per cent plus, 23.30c.; 98@99 per cent, 22.90c. London, £85, less 2 per cent, per long ton, for 98 per cent ingots and bars.

ANTIMONY—Per lb., duty paid, Chinese, spot, 6.75c.; futures, 6.50c. Cookson's "C" grade, spot, 11½c. "CMC." grade, 99.9 per cent, spot, 11c.

BISMUTH—Per lb., in ton lots, $1.50. London, 6s.

CADMIUM—Per lb., 55c. London, 1s. 9d.@1s. 10d.

CHROMIUM—Per lb., 97@98 per cent grade, 85@90c. per lb. contained chromium, maximum 1 or 2 per cent iron.

COBALT—Per lb.: Metal imported from Belgium, 97@99 per cent, $2.50 less 35 per cent for cash. On yearly requirements, usual rebate of 5 to 10 per cent, as to quantity. London quotes 9s., subject to usual discounts.

INDIUM—Per gram, minimum 99 per cent, $14@$15; 98½ per cent, $90@$100 per oz.

IRIDIUM—Per oz., $100@$105 for 98@99 per cent sponge and powder.

MAGNESIUM—Per lb., ingots (4x16 in.), 99½ per cent, 48c., in 100-lb. lots or more; 2½- or 3-lb. sticks (1⅛x27 in.), 53c., 100-lb. lots or more. London, 2s. 9d.@3s. for 99 per cent ingots or sticks.

MANGANESE—Per lb., 95@97 per cent, 42c.

MOLYBDENUM—Per lb., in 10- to 50-lb. lots, C.P. powder, $9; 97 per cent, $4.50. (Usually sold as calcium molybdate or ferromolybdenum, which see.)

NICKEL—Per lb. electrolytic cathodes, 35c.; shot and ingot made from remelted electro, 36c. for single lots of spot metal. London, per long ton, £170 @£175, as to quantity.

OSMIUM—Per oz., $60@$65. Nominal. London, £13 to £14.

PALLADIUM—Per oz., $19@$21. London, £3 12s. 6d.@£4.

PLATINUM—Per oz. Official price of leading interest $40. Cash transactions between dealers and refiners at $2 less. London official price £8. Average price of Colombian crude for June, basis 85 per cent platinum, was $23.

QUICKSILVER — Per 76-lb. flask, $83@$88. Inquiry was a little better, but lower prices failed to result in much business. London quotes £16 12s. 6d.@ £16 15s.

RADIUM—Per mg. radium content, $50 in lots of 4 grams or more, to $65 for 1 gram; smaller quantities, $70.

RHODIUM—Per oz., $45@$50.

RUTHENIUM — Per oz., $40@$45.

SELENIUM—Per lb., $1.80@$2, depending on quantity, for black, powdered, 99.5 per cent pure. London, 7s. 8d.@7s. 9d.

SILICON—Per lb., minimum 97 per cent Si, maximum 1 per cent Fe, 15@17c.

TANTALUM—Per kilo, $91 for C.P. bar or sheet.

TELLURIUM—Per lb., $2. London, 9s. 6d.

THALLIUM—Per lb., $12.50@$15.

TITANIUM—Per lb. in 50- to 100-lb. lots, 75 per cent, $5.

TUNGSTEN—Per lb. contained tungsten, 98 per cent, powdered, $1.45.

Metallic Ores

Prices in tons of 2,000 lb., or in "units" of 20 lb., unless otherwise stated.

ANTIMONY ORE—No sales reported. London, per long ton unit, 3s.@3s. 6d. for 60 to 65 per cent sulphide ore.

BERYLLIUM ORE—Per unit of BeO, minimum 11 per cent BeO, $4@$5, f.o.b. mines. Per lb. BeO contained, 30c., c.i.f. European ports. Nominal.

CHROME ORE—Per long ton, c.i.f. Atlantic ports, Indian ores, $17 for 46@ 48 per cent Cr_2O_3 ore, and $19.50@$20 for 50@51 per cent ore. London, 75s. for 48 per cent Rhodesian, and 77s.

Daily Prices of Metals

July	Electrolytic Copper	Straits Tin	Lead		Zinc
	Refinery	New York	New York	St. Louis	St. Louis
9	7.775	25.10	4.40	4.225	3.85@3.90
10	7.775	25.65	4.40	4.225	3.85@3.90
11	7.775	25.65	4.40	4.225	3.85@3.90
13	7.525	24.50@25.125	4.40	4.225	3.90
14	7.525	24.625@24.75	4.40	4.225	3.90
15	7.525	24.00 @24.25	4.40	4.225	3.90
Av'ge	7.650	25.004	4.400	4.225	3.888
16	7.525	24.75	4.40	4.225	3.90
17	7.525	25.25	4.40	4.225	3.90
18	7.525@7.775	25.125	4.40	4.225	3.95@4.00
20	7.65 @7.775	25.25	4.40	4.225	3.90
21	7.525@7.775	25.00	4.40	4.225	3.875@3.95
22	7.525@7.775	24.50	4.40	4.225	3.90
Av'ge	7.619	24.979	4.400	4.225	3.915

Average prices for calendar week ended July 11, 1931, are: Copper, 7.867c.; Straits tin, 25.663c.; New York lead, 4.400c.; St. Louis lead, 4.225c.; Zinc, 3.892c.; Silver, 28.771c.

Average prices for calendar week ended July 18, 1931; are: Copper, 7.546c.; Straits tin, 24.792c.; New York lead, 4.400c.; St. Louis lead, 4.225c.; Zinc, 3.913c.; Silver, 28.021c.

The above quotations are our appraisal of the major markets for domestic consumption based on sales reported by producers and agencies. They are reduced to the basis of cash, New York or St. Louis, as noted. All prices are in cents per pound.

Copper, lead, and zinc quotations are based on sales for both prompt and future deliveries; tin quotations are for prompt delivery only.

In the trade, copper prices are quoted on a delivered basis; that is, delivered at consumer's plant. As delivery and interest charges vary with the destination, the figures shown above are net prices of refineries on the Atlantic seaboard. Delivered prices in New England average 0.225c. per pound above those quoted.

Quotations for copper are for the ordinary forms of wirebars and ingot bars. For ingots an extra 0.05c. per pound is charged; for slabs, 0.075c.; and for cakes, 0.125c. up depending on weight. Cathodes are sold at a discount of 0.125c. per pound.

Quotations for zinc are for ordinary Prime Western brands. Zinc in New York is now quoted at 0.35c. per pound above St. Louis, this being the freight differential. The contract price for High-Grade zinc delivered in the East and Middle West is 1c. above the St. Louis price for Prime Western.

Quotations for lead reflect prices obtained for common lead, and do not include grades on which a premium is asked.

Silver, Gold, and Sterling Exchange

July	Sterling Exchange "Checks"	Silver		Gold, London	July	Sterling Exchange "Checks"	Silver		Gold, London
		New York	London				New York	London	
9	4.86 5/16	28 3/8	13 1/8	84s10 3/4d	16	4.84 3/8	28 1/4	13 1/4	84s11 1/2d
10	4.86 5/16	28 1/2	13 5/16	84s10 1/8d	17	4.85	27 7/8	13	84s11 1/2d
11	4.86 3/8	28 3/8	13 3/16	.....	18	4.84 3/16	28	13 1/8	.....
13	4.85 3/8	27 7/8	13	84s11 1/2d	20	4.84 3/4	28 1/8	13 1/8	84s11 1/2d
14	4.85 3/8	28	13 1/16	84s11 1/2d	21	4.84 5/8	27 7/8	13	84s11 1/2d
15	4.84	28 1/8	13 1/4	84s11 1/2d	22	4.84 1/16	27 3/4	13	84s11 1/2d

Average for week ended July 15: Silver, 28.208c.; Sterling Exchange, 4.85625.

Average for week ended July 22: Silver, 27.979c.; Sterling Exchange, 4.84500.

New York quotations are as reported by Handy & Harman and are in cents per troy ounce of silver, 999 fine. London silver quotations are in pence per troy ounce of bar silver, basis of 925 fine. Sterling quotations represent the demand market in the forenoon. Cables command five-sixteenths of a cent premium.

London

July	Copper Standard		Electrolytic (Bid)	Tin		Lead		Zinc	
	Spot	3 M		Spot	3 M	Spot	3M	Spot	3 M
9	34	34 11/16	37 1/2	113	114 1/2	12 3/16	12 1/2	11 3/4	12 5/16
10	34 7/16	35 9/16	37 1/2	114	115 3/4	12 11/16	12 15/16	12 3/8	13
13	33 7/8	34 9/16	37	108 1/2	110 1/4	12 9/16	12 7/8	12 3/8	13
14	33 9/16	34 1/4	36	109 1/2	111 1/4	12 11/16	12 7/8	12 11/16	13 5/16
15	33 1/4	34	36	107 3/4	109 1/2	12 1/4	12 1/2	12 3/8	12 15/16
16	33 1/4	34	36	108	109 7/8	12 5/16	12 1/2	12 3/16	12 3/4
17	34 7/8	35 1/2	36	112 3/4	114 3/4	12 15/16	13 1/8	12 3/4	13 5/16
20	34 3/4	35 1/2	37	112 5/8	114 3/8	12 13/16	13 1/16	12 3/8	13 3/16
21	34 5/8	35 3/8	37	111 3/4	113 3/4	12 7/8	13	12 7/16	12 15/16
22	34 1/8	34 7/8	37	110 3/8	112 3/8	12 13/16	12 7/8	12 5/16	12 13/16

Prices for lead and zinc are the official price for the morning session of the London Metal Exchange; prices for copper and tin are the official closing buyers' prices. All are in pounds sterling per long ton (2,240 lb.).

6d.@87s. 6d. for Indian and New Caledonian, according to quality.

IRON ORE—Per long ton, Lower Lake ports. Lake Superior ores:

Mesabi, non-bessemer, 51½ per cent iron, $4.50. Old Range, non-bessemer, $4.65.

Mesabi, bessemer, 51½ per cent iron, $4.65. Old Range, bessemer, 51½ per cent, $4.80.

Eastern ores, cents per long ton unit, delivered at furnaces: Foundry and basic, 56 to 63 per cent, 10c.

Foreign ores, alongside docks Atlantic ports, cargo lots, cents per long ton unit:

North African and Swedish, low-phosphorous, 8½@9½c.

Spanish and North African basic, 50@60 per cent, 8½@9c.

Swedish foundry or basic, 65@68 per cent, 9@9½c.

Newfoundland foundry, 55 per cent iron, 9c. Nominal.

MANGANESE ORE—Per long ton unit of Mn, c.i.f. North Atlantic ports, cargo lots, exclusive of duty: Brazilian, 46@48 per cent Mn, 23c.; Chilean, 47 per cent minimum, 29c.; Indian, 48@50 per cent, 25@26c.; Caucasian, 52@55 per cent, 26@27c.; South African, 52@54 per cent, 25@26c.; 50 to 52 per cent, 24@25c; 44 to 46 per cent, 23½c.

Per ton in carload lots:

Chemical grades, powdered, coarse or fine, minimum 80 per cent MnO_2, Brazilian or Cuban, $60. Javan or Caucasian, 85 per cent minimum, $60. Domestic, 70 to 72 per cent, $60, f.o.b. mines.

MOLYBDENUM ORE—Per lb. of contained MoS_2, nominally 45c., delivered Pittsburgh. London, per long ton unit, nominal at 28s.@30s. for 80@85 per cent concentrate.

TANTALUM ORE—Per lb. Ta_2O_5, 70c. for 60 per cent ore. Market nominal.

TIN ORE — No market in United States. London, returning charge on 60 per cent Bolivian, £8 15s.@£9 per long ton; on 70 per cent Nigerian, £6 17s. 6d., basis £200.

TITANIUM ORE — Per gross ton, ilmenite, 45@52 per cent TiO_2, f.o.b. Atlantic seaboard, $10@$12, according to grade and impurities. Low-grade domestic, 32 to 35 per cent, about $7 @$8. Rutile, per lb., guaranteed minimum 94 per cent concentrate, 10c.

TUNGSTEN ORE—Per unit of WO_3. N. Y.: Chinese wolframite, $11.25, duty paid. Bolivian scheelite, $11.50. Domestic, $12. Shipments of odd carlots do not command full prices.

VANADIUM ORE—Per lb. V_2O_5 contained, 27c., f.o.b. shipping point. London, 16 to 18 per cent V_2O_5, nominal at 45s.@47s. 6d. per long ton unit, c.i.f., on contract.

ZIRCON ORE — Per ton, 55 per cent ZrO_2, f.o.b. Atlantic seaboard, $40@$45 in 30-ton lots. Crude granular zircon, $70, f.o.b. Suspension Bridge, N. Y.; milled, $90.

Non-Metallic Minerals

Prices received for non-metallic minerals vary widely and depend upon the physical and chemical characteristics of the commodity. Hence the following quotations can serve only as a general guide to the prices obtained by producers and dealers in different parts of the United States for their own product. In the last analysis the value of a particular non-metallic mineral can be ascertained only by direct negotiation between buyer and seller.

Tons of 2,000 lb. unless otherwise noted

AMBLYGONITE — Per ton, f.o.b. mines, 8@9 per cent Li_2O, $50@$60.

ASBESTOS — Per ton, f.o.b. Quebec mines, tax and bags included: Crude No. 1, $250@$350; crude No. 2, $200@$250; spinning fibers, $90@$175; magnesia and compressed sheet fibers, $100@$125; various grades shingle stock, $45@$65; various grades paper stock, $27.50@$35; cement stock, $15@$20; floats, $10@$12.

Per ton c.i.f. New York: Rhodesian crude No. 1, $300; No. 2, $200. Nominal.

Per ton, c.i.f. New York: Russian crude No. 1, $220@$250; No. 2, $175@$200; No. 3, $125@$150. Nominal.

Per ton, f.o.b. mines, Vermont: Shingle stock, $55; paper stock, $35; cement stock, $20.

BARIUM CARBONATE (Witherite) — Per ton, 90 per cent 200 mesh, $47: 100 mesh, $44.

BARYTES—F.o.b. mines, bags extra:

Georgia: Barytes ore, crude, $6@$6.50 per long ton.

Missouri: Per ton, water ground and floated, bleached, $23, car lots, f.o.b. works. Crude ore, minimum 95 per cent $BaSO_4$, less than 1 per cent iron, $6.50; 1 per cent iron and 93 per cent $BaSO_4$, $6, f.o.b. mines.

BAUXITE—Per long ton: Domestic ore, chemical, crushed and dried, 55 to 58 per cent Al_2O_3, 1.5 to 2.5 per cent Fe_2O_3, $6.50@$8, f.o.b. *Alabama* and *Arkansas* mines. Other grades, 56 to 59 per cent Al_2O_3, 5 to 8 per cent SiO_2, $6@$7.50, f.o.b. *Arkansas* mines. Pulverized and dried, 56 to 59 per cent Al_2O_3, 8 to 12 per cent SiO_2, $10@$12.25, f.o.b. *Arkansas* mines; abrasive grade, crushed and calcined, 78 to 84 per cent Al_2O_3, $14@$16, f.o.b. *Arkansas* mines.

Per metric ton, foreign, c.i.f. Atlantic ports: Dalmatian, 50 to 55 per cent Al_2O_3, 1 to 3 per cent SiO_2, $4.50@$6.50. Istrian, 54 to 57 per cent Al_2O_3, 3 to 5 per cent SiO_2, $5.50@$7; French, 56 to 59 per cent Al_2O_3, 2 to 4 per cent SiO_2, $6@$8.

BENTONITE—Per ton, carload lots, f.o.b. Wyoming mines, dried and crushed, in bulk, $8: in bags, $10. F.o.b. Chicago, selected air-floated, $25.

BORAX — Per ton, carload lots, in bags, crystals, $56; granulated, $50; powdered, $57.50; f.o.b. shipping point.

[1]CELESTITE—Per ton in carload lots, 90 per cent $SrSO_4$, finely powdered, $27.

CHINA CLAY (KAOLIN)—Per ton, f.o.b. *South Carolina* mines, crude lump, No. 1, $5; crushed air-floated, $7; pulverized, $9@$10.

Florida, washed and crushed, No. 1, $12.50; No. 2, $12.

Delaware, No. 1, $14.50.

Imported English, f.o.b. American ports: lump, $17@$21 in bulk.

EMERY—Per ton, f.o.b. *New York,* domestic crude ore, first grade, $10. Other American ore, delivered to grinders, per gross ton, $15; Turkish and Naxos ore, $30@$35. F.o.b. *Pennsylvania,* in 350-lb. kegs, Turkish, Khasia, and Naxos grain emery, 6½c. per lb.; American, 3½c.

FELDSPAR — Per ton, f.o.b. *North Carolina,* potash feldspar, 200 mesh, white, $15, in bulk; soda feldspar, $18. F.o.b. *Maine,* potash feldspar, white, 200 mesh, $19, in bulk. Granular glasspar, f.o.b. *North Carolina,* $10.50 in bulk.

Virginia, No. 1, 325 mesh, $17; 200 mesh, $15@$15.50; 160 mesh, $14; No. 1 glassmakers', $11; enamelers', $12.50.

New Mexico: Crude clean No. 1 potash spar, $4.75; ground, $9.50.

FLUORSPAR — Per ton, f.o.b. *Kentucky* and *Illinois* mines:

Gravel, not less than 85 per cent CaF_2, and not over 5 per cent SiO_2, $13. Foundry lump, 85-5, $15. Ground, 95 to 98 per cent CaF_2, and not over 2½ per cent SiO_2, $30 in bulk; $34 in bags or barrels. *Colorado* mines, 82-5, $12.75.

Foreign fluorspar, gravel, 85-5, $18.50 per gross ton, duty paid.

FULLER'S EARTH — Per ton, f.o.b. *Colorado,* $18, various finenesses to minus 90 mesh.

F.o.b. *Georgia* or *Florida,* 30 to 60 mesh, $17; 15 to 30, $16; 200 up, $10; 100 up, $7.

GARNET—Per ton, f.o.b. *New Hampshire* mines: concentrate, $40; washed grades, $125.

New York: Adirondack garnet concentrates, $85.

Spanish grades, $60, c.i.f. port of entry.

GILSONITE — Per ton, carload lots, f.o.b. *Colorado:*

Brilliant black, $31.65; seconds (mine run), $25.50.

Selects, $30.50, f.o.b. Utah. Nominal.

GRAPHITE—Per lb., f.o.b. *New York:* Ceylon lump, 6½@7½c.; carbon, lump, 3@6c.; chip, 5@6c.; dust, 3@4c.; Madagascar flake, 5@6c.

No. 1 flake, 8@16c.; No. 2, 6c. upward; fine ground, 3c. upward; amorphous, 3c. upward.

Crude amorphous graphite, $15@$35 per ton, according to grade.

GREENSAND — Per ton, f.o.b. cars, *New Jersey:* Screened and bagged, best grade, in carload lots, $20.

GYPSUM—Per ton, f.o.b. mill, crushed rock, *Iowa,* $2.50; *Ohio* and *New York,* $3. Ground, *Ohio,* $4; *Iowa,* $6. Agricultural, $6@$7. Calcined, $6@$9.

IRON OXIDE (See Ocher)—Per lb.: Standard Spanish red, 3@4½c.; domestic earth, 2@4½c.

KAOLIN—See China Clay.

LEPIDOLITE—Per ton, $50@$60 for ordinary grades. Nominal.

LIMESTONE—Per ton, f.o.b. shipping points, depending on location, either lump or crushed, 25c.@$1.75.

Agricultural, $1 up to $6 per ton, as to grade and point of shipment.

MAGNESITE—Per ton, f.o.b. *California,* dead-burned, $25. Kiln run, 93 per cent MgO (artificial periclase), $68; 88 per cent MgO, $35. Caustic, 95 per cent MgO, $45; 90 per cent, $40. *Washington:* Dead-burned grain magnesite, $22.

MICA—Per ton, f.o.b. *New Mexico* scrap, white, $21; off color, $18. Punch, white, for disks, per lb., 10c.; for washers, 8c.

Per ton, f.o.b. *New Hampshire,* roofing mica, $23; snow, $34; 40 mesh white, $40; 60 mesh, $48; 100 mesh, $60; 200 mesh, $75. Clean dry mixed bench and mine scrap, $13.

Per lb., f.o.b. *North Carolina* Punch, 4@5c.; 1½x2 in., 25@35c.; 2x2, 45@60c.; 2x3, 85c.@$1; 3x3, $1.40@$1.60; 3x4, $1.80@$2; 3x5, $2@$2.25; 4x6, $2.75@$3; 6x8, $3.50@$3.75; 8x10, $5@$7.50. These prices apply both to No. 1 and No. 2 mica Black-stained mica takes a discount of 10 to 25 per cent from this schedule. White North Carolina mica, 70 mesh, $60 to $80. Biotite, or black mica, $15 a ton, unground.

MINERAL BLACK—(Graphitic shale) —Per ton, 325 mesh, 75 per cent carbon, $22.50, f.o.b. *Virginia.*

MONAZITE—Per ton, minimum 6 per cent ThO_2, $60.

OCHER — Per ton, f.o.b. *Georgia* mines, $17.50 in sacks; $20 in barrels; second grade, $10. Buff clay, 98 per cent through 325 mesh, $18.

F.o.b. *Virginia,* dark yellow, 300 mesh, 60 per cent ferric oxide, in jute bags, $19.50.

PHOSPHATE—Per long ton, f.a.s. or f.o.b. mines:

Florida, pebble, f.a.s., for export: 76@77 per cent, $7.15; 75 per cent, $6.40; 74@75 per cent, $6.15; 70 per cent, $4.65; 68 per cent, $4.10.

Florida, pebble, domestic: 76@77 per cent, $6.50; 74@75 per cent, $5.50; 72 per cent, $4.50; 70 per cent, $4.

Tennessee, ground lime phosphate, 80 per cent through 300 mesh, 33 per cent P_2O_5, $12.80 per net ton, bags extra.

PUMICE STONE—Per lb., in barrels, powdered, 2½@4c.; selected lump, 5@7c.

PYRITES—Per long ton unit of sulphur, c.i.f. United States ports, guaranteed 48 per cent sulphur, Spanish, 13@13¼c.

POTASH—Per ton, contracts:

	Bags	Bulk
Muriate of potash, 80@85 per cent, basis 80 per cent	$37.15	$35.55
Sulphate of potash, 90@95 per cent, basis 90 per cent	48.25	46.65
Sulphate of potash-magnesia, 48@53 per cent, basis 48 per cent	27.80	26.20
Manure salt, 30 per cent	22.15	19.15
Manure salt, 20 per cent	15.65	12.65
Kainit, 14 per cent	12.70	9.70

Prices are delivered to Atlantic ports. Discounts up to 4 per cent for early shipment. Spot prices, $1.25@$1.50 per ton higher than on contract.

[1]QUARTZ ROCK CRYSTALS—For fusing, all sizes, $250 per ton. Prisms for piezo-electrical use, $3 per lb. in small lots. Optical grades command premium.

SILICA—Per ton, water ground and floated, in bags, f.o.b. *Illinois:* 325 mesh, $16@$40 for 92 to 99½ per cent grades. Dry ground, air-floated, 325 mesh, 92@99½ per cent silica, $14@$30. Market steady. Glass sand, f.o.b. producing plant, $1.25@$5 per ton; molding sand, 50c.@$3.50; blast sand, $1.75@$6.

[1]STRONTIANITE — Per ton, lump in carload lots, minimum 90@92 per cent $SrCO_3$, $100.

SULPHUR—Per long ton for domestic market, $18 f.o.b. Texas mines; $22 for export, Atlantic ports.

TALC — Per ton, carload lots, f.o.b. works, containers included unless otherwise specified:

New Jersey: Soapstone, ground, $10@$12.

New York: Double air-floated, short fiber, 200 mesh, $13.75; 325 mesh, $14.75.

Vermont: 99 per cent through 200 mesh, extra white, bulk basis, $8@$8.50; 97 to 98 per cent through 200 mesh, medium white, $7@$7.50. Packing in paper bags, $1 per ton extra.

Virginia: 200 mesh, $6@$7.75; 325 mesh, $8.75@$10.50.

TRIPOLI — Per ton, burlap bags, paper liners, minimum carload 30 tons, f.o.b. *Missouri:* Once ground through 40 mesh, rose and cream colored, $15. Double ground through 110 mesh, rose and cream, $17. Air-floated through 200 mesh, rose and cream, $22.50.

Metallic Compounds

ARSENIOUS OXIDE (White arsenic)—Per lb., 4c., delivered, all positions. London, per long ton, £20 for Cornish white. Mexican, high grade, £17 10s.

CALCIUM MOLYBDATE OR MOLYTE—Per lb. of contained Mo, 85c.

COBALT OXIDE—Per lb., black oxide, 70@71 per cent grade, $1.35.

COPPER SULPHATE (Blue Vitriol)—Per lb., in car lots, 3.60c. for either large or small crystals.

GERMANIUM DIOXIDE—Per gram, in 200- to 300-gram lots, $3.50.

SODIUM NITRATE—Per 100 lb., crude natural, in bags ex vessel, Atlantic ports, $2.05.

SODIUM SULPHATE (Salt Cake)—Per ton, bulk, f.o.b. works, $15@$18.

ZINC OXIDE—Per lb. in bags, in car lots: Lead-free, 6½c.; 10, 20 or 35 per cent leaded grades, 6¼c.; French red seal, in bags, 9⅜c.

ZIRCONIUM DIOXIDE—Per lb. in 100- to 500-lb. lots, 87 per cent ZrO_2, commercial, 50c.

Refractories

CHROME BRICK—Per ton, f.o.b. shipping point, $45. Grecian refractory ore, 37@42 per cent, 40c. per unit.

FIRECLAY BRICK — Per M., first quality, $40, *Ohio, Kentucky, Central Pennsylvania;* second quality, $35.

MAGNESITE — Brick, per ton, f.o.b. works, 9-in. straights, $65. Dead-burned grain, $40, f.o.b. Chester, Pa., or Baltimore.

SILICA BRICK—Per M., *Pennsylvania*, $40; *Alabama*, $50@$51; *Illinois* and *Indiana*, $49.

ZIRKITE—Per lb., powdered, 65@70 per cent ZrO_2, 3½c. Brick, straights, 80c.@$1 each.

Alloys

FERROCHROME — Per lb. of contained chromium, 4 to 6 per cent carbon, 65 to 70 per cent chromium, 11c., delivered, on contracts; spot, 11½c. Containing 2 per cent carbon, 67 to 72 per cent chromium, spot, 17½c.; maximum 0.10 per cent carbon, 26c., spot; 24½c. contracts.

FERROMANGANESE — Per gross ton furnace: domestic and foreign, 78@82 per cent, $80@$85, contracts, depending on quantity. Spiegeleisen, 19@21 per cent, $30 for spot carloads.

FERROMOLYBDENUM—Per lb. of Mo, f.o.b. shipping point, 50@60 per cent Mo, $1.

FERROPHOSPHORUS—Per gross ton, 18 per cent P, $91; electrolytic, 24 per cent, $122.50, f.o.b. *Alabama* and *Tennessee*.

FERROSILICON — Per gross ton, delivered, 50 per cent, $83.50; 75 per cent, $130; 14@16 per cent, $31, f.o.b. Niagara Falls, N. Y. Spot shipments $5@$10 per ton higher on 50 and 75 per cent grades.

FERROCARBONTITANIUM — Per ton, $150, f.o.b. producer's plant, carlots.

FERROTUNGSTEN—Per lb. of W contained, 75@80 per cent W, $1@$1.10, f.o.b. works.

FERROVANADIUM—Per lb. of V contained, delivered, $3.15@$3.50.

SILICOMANGANESE — Per long ton, carload contracts, delivered, $105 for maximum 2½ per cent carbon; $115 for maximum 1 per cent carbon.

SILICON ZIRCONIUM—Per lb., 47@52 per cent Si, 35@40 per cent Zr, 18@21c.

ZIRCONIUM FERROSILICON—Per gross ton, 12@15 per cent Zr, 39@43 per cent Si, $103.50@$108.50.

Rolled Metals

COPPER — Per lb., sheets, hot-rolled, 17⅞c.; wire, f.o.b. mill, 9¾c.

LEAD SHEETS — Per lb., full rolled, 7¼c.; clipped, 7½c.

MONEL METAL—Per lb., sheets, full finished, 42c.; rods, hot-rolled, 35c.

MUNTZ METAL—Per lb., rods, 14¾c.; plates, 17⅜c.

NICKEL—Per lb., sheets, full finished 52c.; rods, hot-rolled, 45c.

NICKEL SILVER — Per lb., sheets, 10 per cent, 22⅞@23¼c.; 18 per cent, 26⅜@26¾c. Wire and rods, 10 per cent, 26⅜c.; 15 per cent, 30⅜c.; 18 per cent, 33⅞c.

PHOSPHOR BRONZE—Per lb., sheets and rods, 5 per cent tin, 29⅛c.; wire, 5 per cent, 29⅝c.; 10 per cent, 35⅛c.

ZINC SHEETS—Per lb., 9c., f.o.b. works; ribbon 8½c.; 7 per cent discount on orders for 18 tons or more.

Iron, Steel, and Coke

IRON—Per gross ton, Valley furnaces: Bessemer, $17; basic, $17; and No. 2 foundry, $17.

STEEL—Per gross ton, base prices, Pittsburgh, billets and slabs, $29@$30; bars, plates, and structural shapes, per 100 lb., $1.60@$1.65.

COKE—Per ton, Connellsville furnace, $2.40@$2.50. Connellsville foundry, $3.25@$4.50. Byproduct coke, Ohio and Kentucky (Connellsville basis), $5.50; Buffalo and Detroit, $8@$8.50; Birmingham, foundry, $5; furnace, $3.50@$4.50.

[1]Price furnished by Foote Mineral Company, Philadelphia.